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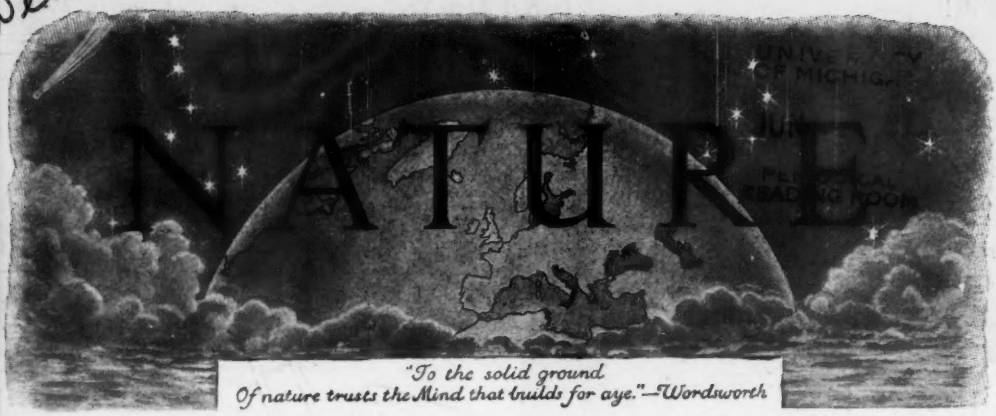

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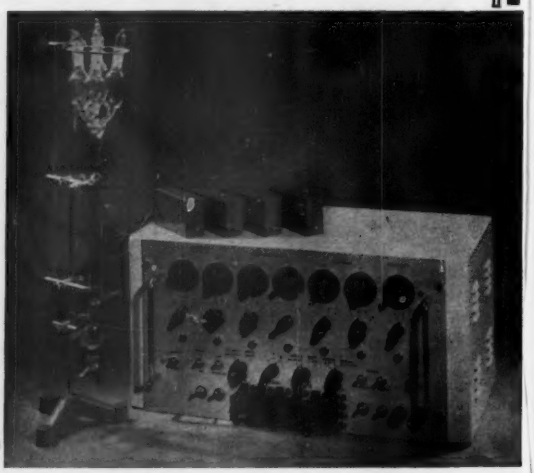

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GOVERNMENT RESEARCH IN BRITAIN

THE report of the Advisory Council for Scientific and Industrial Research for 1953–54 (see p. 965 of this issue) reveals clearly how slender is the real expansion in the work of the Department of Scientific and Industrial Research that will be possible through the programme outlined in the House of Commons on December 8, 1953. Of the increase of £578,379 for 1954–55 compared with 1953–54, more than £300,000 represents an increase in the contribution to the European Organization for Nuclear Research; of the increase of £260,000 in the Department's net vote for 1955–56, a further £160,000 goes for the same purpose. Even a slight increase in running costs or in salaries thus means that at best the increased vote will enable the Department to maintain its activities at the current level, and that there will be no provision for overall expansion.

This does not, of course, mean that some of the Department's work will not be expanded, even if that involves the curtailment of other activities; indeed, the most important and encouraging feature of the present report is the evidence it affords that the Advisory Council is reviewing the whole work of the Department and that under the terms of the statement made on December 8, 1953, such review and planning can proceed on a quinquennial and not a year-to-year basis. Within the limits of its present resources, the work of the Department is now clearly being carried out more effectively in relation to national needs and without the waste of effort and resources involved in snap decisions on an annual basis. The Advisory Council, in fact, regarded as its most important tasks in the year under review the study of the needs of the various branches of the Department's work in the light of the conditions of to-day, and advice where the increased effort available is most urgently needed.

In particular, a rapid decision on the distribution of the proposed increases of about 150 non-industrial staff per annum, with about one-third that number of industrial staff, as they become available, was imperative. Since the post-war plans outlined in 1948 were formulated, new needs have arisen. The Advisory Council therefore does not take the view that, since adequate resources will be available to cover some 95 per cent of the activities projected in that plan, this implies that those resources are to be distributed rigidly in accordance with the details of the plan. Rightly it is attempting to re-assess the problems confronting the Department as a whole, and to allocate resources in the light of the circumstances of to-day. There is some evidence in this report that it is also guided by the view that the Department's activities in general should not be strictly limited to those which are considered appropriate to a Government organization, but should also be extended to cover work best carried out in that way or unlikely otherwise to be carried out at all. In particular, the revised terms of grant to the research associations, while designed to encourage the expansion of that work, are equally designed to require more substantial effort from the industries served by the research associations.

The interim decision on distribution of the additional non-industrial staff, reached in January 1954 with the help of a preliminary survey of current objectives and distribution of effort, allocated rather more than 100 of the 150 to be available by April 1, 1955, between the Mechanical Engineering Research Laboratory, the Road Research Laboratory, the Water Pollution Research Laboratory, the Hydraulics Research Station and the Fuel Research Station. By July, however, a more detailed analysis of the Department's current programmes and objectives was available; and the Advisory Council is making further recommendations for the distribution of the extra staff to become available during the remaining four years in the light of this analysis and its own further experience, which, during the year, was concerned mainly with fourteen establishments, three of which were visited corporately. Nevertheless, the Advisory Council found it no easy task to assess quantitatively the importance of the work of one of the Department's establishments as against another. A quantitative basis for a decision, for example, to expand pest infestation research rather than water pollution research or *vice versa*, is hard to find, though the Council has no hesitation in saying that, at present, there is no establishment in the Department to which considerably greater resources could not, with profit, be assigned.

The Advisory Council, however, is not only conscious of the desirability of relating the Department's activities to proved national needs and to those which are appropriately met by a government establishment rather than by industry itself or a private or independent research institution: it is equally conscious that limits to its recommendations are set by the man-power situation, as well as by the financial resources which Parliament puts at its disposal. Indeed, quite as encouraging as the indication that the Advisory Council is now able to plan its activities over a term of years, instead of from year to year, and that it is closely scrutinizing those activities in relation to national needs, is the evidence that such investigation and planning are also carried out in full consciousness of the vital claims of the universities and schools as well as of industry to available resources of scientific man-power. Specifically it welcomes the survey of the distribution of graduates between industrial, academic and other posts which Political and Economic Planning is carrying out. It recognizes that the shortage of scientists sets its own limit, and the Council is not attempting to claim more than a fair share of scientific man-power for the Department's activities. Whether the claim is excessive or too modest is not for the Advisory Council to say. It is one on which the Advisory Council for Scientific Policy might well be expected to comment, and the main responsibility for decision lies with the Lord President of the Council, to which the Council's report is submitted.

Leaving, therefore, the question whether or not the Advisory Council is right to accept the five-year proposals as a reasonable current assessment of the share of Government expenditure and of the country's scientific man-power to be devoted to the work of the Department, some comments of the Advisory Council on the scale of particular activities should be noted. Attention has already been directed to the high proportion of the additional funds which will be absorbed by the European Organization for Nuclear Research. Besides this, the Department is contributing about £300,000 a year in support of nuclear research in universities, so that out of the Department's £6¼ million in 1954–55, some £650,000, and out of its £6·5 million for 1955–56, more than £800,000, goes for research in this one field. Beyond indicating the constitution of a full committee of its Scientific Grants Committee to consider all applications for grants for research in this field and to keep under review all the scientific aspects of the Department's responsibilities here, the Advisory Council makes no comment on this situation. Whether the proportion of effort in nuclear physics is excessive cannot be judged from this report; but this high proportion of effort in a single field should be remembered in the context that no account is taken of the demands represented in the £50 million voted for the Atomic Energy Corporation, and that even the latter amount does not include man-power or finance and materials which are expended in nuclear physics for defence purposes.

That is obviously a situation that demands consideration at a high level, and while public discussion of all its aspects may be undesirable for security reasons, this in itself is a reason for insisting that the Lord President should take every care to make it manifest that he is adequately provided with scientific advisers whose quality commands confidence, and that their advice is effectively rendered and disseminated. Something appears to have been done recently in this direction so far as the Minister of Defence is concerned; but the position remains unsatisfactory in regard to the Lord President of the Council, both *vis-à-vis* Parliament itself and the several research councils and other scientific bodies. This is perhaps a matter which the Parliamentary and Scientific Committee could with advantage pursue.

On building research, the Advisory Council expresses the opinion that the Building Research Station has been instrumental in introducing marked improvements into building practice, often pointing the way simultaneously to better quality and to economy in effort and materials. It believes that there is widespread and growing appreciation of the Station's work among government departments, among professional men and all branches of the building industry in Britain. The first major expansion in the Department to meet post-war needs was made for building research, while, in 1950, the Chief Scientific Adviser's Division of the Ministry of Works, which is concerned with the study of the economic, sociological and productivity aspects of the building industries, was transferred to the Department. Although the proportion of the Department's resources devoted to building research has since been reduced, the non-industrial staff of the Station is still about 14 per cent of the total for all the establishment.

The Advisory Council has no doubt that there is justification for extending research on building, and hopes there will be even further expansion. Rightly it points out that the staff cannot be expected to continue to increase at government expense, proportionately to the total increase in the Department as a whole. It suggests, therefore, that any substantial increase in the resources for building research, within the Department, or elsewhere, must be sought outside the Department; and it makes the pertinent comment that the building industry as a whole does not appear to make so large a contribution to research for its own benefit as do most industries, and as it might do.

The Advisory Council, in this connexion, welcomes a recent arrangement by which the National Federation of Building Trade Employers has agreed to provide means for the full-scale trials of the results of certain studies at the Building Research Station; and it suggests that larger firms, or collective bodies, in the industry might create research studentships or fellowships tenable at the Station, or send to the Station, for research apprenticeships as it were, young men whom they proposed to take on to their own staffs. What the situation seems to demand is some such survey of the industry and its research organization as has been carried out already in respect of a few research associations. The Advisory Council makes no such recommendation, though an independent survey might well produce some forthright as well as constructive comment, not merely on the research attitude of the industry, but also on the decision to discontinue operational research; and on such ventures as the creation of the Scottish Laboratory, which almost inevitably would seem to entail some duplication of Government effort that more co-operation and enterprise on the part of the industry in Scotland would obviate.

The Mechanical Engineering Research Laboratory is another field in which the Advisory Council sees limits to expansion on the present rapid scale. The recruitment of non-industrial staff authorized for the year under review brings the total of such staff to some 7 per cent of the Department's total, and the total at least will grow over the next few years as new buildings become available. While the Council is impressed by the importance of the work in progress and is satisfied that the Laboratory will make valuable contributions to the scientific and technical knowledge essential for the continued efficiency of the engineering and allied industries, it indicates that the needs will in future have to be weighed against those of other branches of the Department's work.

The Advisory Council is specially concerned at present to promote the work of the Fuel Research Station and the Road Research Laboratory. In the thirty-five years since the former was established, its position and outlook have been altered by the formation of various research associations, like the British Coal Utilization Research Association, by the

increased interest taken in fuel research by other industrial organisations, by the research responsibilities laid upon the new nationalized industries in their specific fields and by the responsibility vested in the Ministry of Fuel and Power "for the co-ordinated development of all sources of fuel and power and for promoting their economical and efficient use". While the Fuel Research Board has kept the programme of the Station constantly under review in the light of these developments, and with particular regard to the transfer of appropriate sections of the Station's work, the demands on the Fuel Research Station remain heavy and difficult to meet satisfactorily. More staff and rapid provision of a new research station have become imperative. The Advisory Council has sanctioned an immediate increase in staff to accelerate work on atmospheric pollution and domestic heating, and the planning of a new station is being considered in the context that it is still necessary for the Station to maintain its position as a national centre for the study of fuel problems.

Priority in the distribution of the increased resources available to the Department in the year under review has also been given to the Road Research Laboratory, on which the Advisory Council is convinced that more money could be spent to advantage. The provision now being made for a new station, on a much larger site at Crowthorne, Bucks, includes, as a first step, space for a much-needed experimental road circuit, which is being constructed in advance of the general building of the new station.

Two further matters in the Advisory Council's report call for comment. Under the heading "Human Factors in Industry", the Advisory Council refers to programmes of research in the social sciences which the Department has sponsored jointly with the Medical Research Council, and largely with the support of Conditional Aid Counterpart Funds. This work is mainly concerned with problems of management and of human relations arising from technological change. Like that on production economics, also largely supported from Conditional Aid Counterpart Funds, it bears closely on industrial efficiency and is also concerned with the dissemination of information with which the new section of the Intelligence Division—the Industrial Operations Unit—of the Department is likewise engaged.

There is no indication in the "Summary of Expenditure" of the extent to which the Department's resources are committed to this new field which, as the Advisory Council recognizes, is outside those of natural science and technology, with which the Department has been predominantly concerned in the past. Without questioning the value and importance of such programmes to industrial progress, it should be recognized that there is here a trend which, apart from its somewhat dubious dependence upon Counterpart Funds, could lead to the real magnitude of the Department's contribution to scientific and industrial research being somewhat masked. There is no *prima facie* purpose in mixing expenditure on sociological research with that on scientific and technological research in the usually accepted sense, however significant may be the contribution that sociological research may make to industrial development.

Although the amounts at present involved appear to be small, it is important that confusion should be avoided from the start, and much the same applies to the second matter calling for comment. From its inception, the Department has had a close interest in the training of research workers, through its system of research awards and maintenance allowances. In recent years the educational functions of the research associations have become of increasing importance, and resulted, in the period covered by the report, in a conference on November 27, 1953, to discuss the part such research associations could play in advancing technological and technical education. The Advisory Council recognizes the importance and value of this function, and its report indicates that the Department is exploring other possibilities of improving postgraduate instruction to meet the requirements of industry.

Nevertheless, here again the danger exists that a considerable and unknown proportion of the Department's resources will be spread over a field—that of education—which cannot be specifically described as scientific and industrial research. Scientific and industrial research has, of course, a certain educational value, both in its execution and in the dissemination of its results, and it would be impracticable to draw a sharp distinction between the research and the educational functions of the Department. None the less, a stage appears to have been reached when the Department's expenditure as presented may give a fictitiously high impression of the actual expenditure on research; some means should also be sought of giving a figure for its educational activities. This is important, less perhaps in relation to the Department's own accounts at present than in relation to the national expenditure on higher education. It is an argument for a more determined effort to obtain an overall picture of the distribution of the resources of Great Britain in research, in university education, in technological education and in technical education, in such a way that sound decisions are possible as to re-allocation where necessary, and at such a level that effective action can be taken without being thwarted by sectional views or departmental prejudice.

IMPORTANCE OF PORPHYRINS IN MEDICINE

Porphyrins

Their Biological and Chemical Importance. By Prof. A. Vannotti. (Translated by Prof. C. Rimington.) Pp. ix + 258 + 15 plates. (London: Hilger and Watts, Ltd., 1954.) 50*s*. net.

IN 1937 the firm of J. Springer, Berlin, published a book entitled "Porphyrine und Porphyrinkrankheiten" by Dr. A. Vannotti, professor of medicine in the University of Lausanne. That book, which ably summarized the clinical literature on porphyrias and related conditions and other biological work, has not been available in Britain for some time. In addition, a large amount of work has been done in this field

in recent years, and the publication of the present volume is welcomed. Clinicians and others with special interests in porphyrins will be grateful to Prof. C. Rimington for having undertaken the task of translating the book into English.

The main value of the book lies in the chapters dealing with the clinical and pathological aspects of porphyrins. Here Prof. Vannotti draws upon his own wide experience and his intimate knowledge of the clinical literature. Many original papers, to which reference is made, have appeared in European journals not readily available, and this feature makes the book particularly valuable to the English-speaking reader. Specialists will not always agree with Prof. Vannotti, for example, in his assessment of vitamins in the treatment of porphyria. There is also some doubt whether some of the methods, such as those recommended for the separation of porphyrins, are sufficiently reliable or accurate according to modern standards. Nevertheless, this book will be of value to the clinician or pathologist interested in porphyrias or other conditions in which increased amounts of porphyrins are excreted.

Prof. Vannotti states in his foreword that this book "is, in no sense, a mere revision of the older monograph, but a new book embodying modern conceptions of pigment metabolism". But the reader who expects on seeing the title and sub-title an up-to-date account of the organic chemistry, physical chemistry, biosynthesis or metabolism of porphyrins will be somewhat disappointed. The structural chemistry is given in a very elementary form, and the physical chemistry is curiously old-fashioned. Neither can the treatment of the general biochemistry of the porphyrins be considered satisfactory. Thus no reference is made to the important work of Granick, which shows that porphyrins are precursors of chlorophyll in algæ. Recent results elucidating, by means of isotopes, the steps leading from glycine and succinic acid to porphyrins are mentioned, but are not adequately discussed, nor are they woven into the general fabric of the book.

One feels therefore that, while this book of Prof. Vannotti will be of great value to the medical, and particularly clinical, reader, it cannot be recommended as a general introduction into the chemistry, biochemistry or biology of porphyrins.

A. Neuberger

PSYCHOLOGY AND MYTHOLOGY

The Origins and History of Consciousness

By Dr. Erich Neumann. (Translated by R. F. C. Hull.) Pp. xxiv+494+27 plates. (London: Routledge and Kegan Paul, Ltd., 1954.) 30*s*. net.

THIS book is *not* concerned, as its title might lead the unwary reader to suppose, with the classical problem of the emergence of consciousness in the evolution of living matter: it is concerned with the emergence of consciousness from 'the unconscious mind'. The central theme is yet another psychological variant of the thesis that 'ontogeny recapitulates phylogeny'. What is distinctive of this variant is the idea that both the ontogenetic and the phylogenetic sequence correspond to that of a series of mythologies, these mythologies being symbolical projections of struggles within the human psyche.

"It is the task of this book", writes the author, "to shew that a series of archetypes is a main constituent of mythology, that they stand in an organic relation to one another, and that their stadial succession determines the growth of consciousness". This is fairly clear, but the author proceeds: "Normally the archetypal stages are lived through without disturbance, and the development of consciousness proceeds in them just as naturally as physical development proceeds in the stages of bodily maturation. As organs of the psyche's structure the archetypes articulate with one another autonomously, like the physical organs, and determine the maturation of the personality in a manner analogous to the biological hormone-components of the physical constitution".

Gathering momentum, the argument plunges to quite incredible depths of obscurity. The following is fairly representative of the style and texture of the exposition: "Besides possessing an 'eternal' significance, the archetype also has an equally legitimate historical aspect. Ego consciousness evolves by passing through a series of 'eternal images', and the ego, transformed in the passage, is constantly experiencing a new relation to the archetypes. Its relation to the eternality of the archetypal images is a process of succession in time—that is to say, it takes place in stages. The ability to perceive, to understand, and to interpret these images changes as ego consciousness changes in the course of man's phylogenetic and ontogenetic history; consequently the relativity of the eternal image to the evolving ego consciousness becomes more and more pronounced".

The work, however, is clearly addressed to advanced students of Jungian psychology, and for them no doubt it is an essential text. It is commended to them in a foreword by Jung himself. He describes it as beginning where he himself, were he granted a second lease of life, would start to gather up the *disjecta membra* of his own writings. He commends it, too, as presenting "a unique history of the evolution of consciousness", and as representing the body of myths as the phenomenology of this same evolution.

It would certainly seem that the author has something important to say, but it is difficult not to believe that what he has to say could have been said more clearly.

C. A. Mace

CHEMICAL SPECIFICITY IN BIOLOGICAL INTERACTIONS

Chemical Specificity in Biological Interactions

Edited by Frank R. N. Gurd. (Memoirs of the University Laboratory of Physical Chemistry Related to Medicine and Public Health, Harvard University—No. 3.) Pp. xv+234. (New York: Academic Books, Inc.; London: Academic Books, Ltd., 1954.) 6 dollars.

APART from the introductory chapter by the late Dr. E. J. Cohn, this book consists of two independent parts, the first of which is made up of five papers, as follows: the effects of X-ray and other radiations on proteins and living tissues, by S. Warren; physical and chemical properties of the steroids related to protein binding, by R. B. Turner; biochemical problems of the steroid hormones, by T. F. Gallagher; some studies on the active principles of the posterior pituitary gland, by V. du Vigneaud; and the influence of ion-exchange chromatography

upon our concept of the structure of ribonucleic acid, by W. E. Cohn. This is a rather heterogeneous collection of titles; though they could each deal with the subject of the symposium from a different point of view, the authors do not really appear to have this in mind. However, each of these five papers is a very clear exposition written by distinguished people about their own researches. The lectures published here were originally delivered at Harvard in February and March 1952. Clearly, seminars on original researches lose much if published two and a half years later.

The second part of the book consists of four papers by C. D. Coryell, J. Schubert, G. Schwartenbach and G. Scatchard (with W. L. Hughes, F. R. N. Gurd and P. E. Wilcox) which present a unified story. Before the Second World War the main interest of the Department of Physical Chemistry at Harvard University Medical School was in the ionizing groups of amino-acids, peptides and proteins and the properties of these compounds which are a consequence of their ionic side-chains. After the War such knowledge was applied in a number of laboratories to the study of the interaction of amino-acids and proteins with metals and other ions. The results of such studies can give information about the reactive groups on the surface of protein molecules, they can define the catalytic sites of enzymes and they can give information about the specific role of certain metals in some enzyme catalysis mechanisms. Furthermore, E. J. Cohn and his colleagues have made great use of specific metal–protein interactions for the purification of certain proteins.

The four papers of the second half of the book deal with the fundamental aspects of the interaction of metals with small molecules and proteins from a theoretical point of view, and give a good review of the available experimental results. Such a good account of the work in this field, which is going on at Harvard and in several other laboratories, is very welcome. It is a pity that some of the space of this volume has not been devoted to quantitative data for van der Waals forces in specific protein–protein enzyme–substrate and antigen–antibody interactions.

H. Gutfreund

ION-SOLVENT INTERACTION IN SOLUTIONS

Ionic Processes in Solution

By Dr. Ronald W. Gurney. (International Chemical Series.) Pp. ix+275. (London: McGraw-Hill Publishing Co., Ltd., 1953.) 46*s*. 6*d*.

THE properties of an electrolyte solution are influenced by long-range Coulomb forces, by the effect of each ion on the solvent molecules in its neighbourhood, and by the nature of the close-range forces when ions approach one another and their zones of modified solvent interact. Since the acceptance of the Debye–Hückel theory, the centre of interest in electrolyte solutions has been in the shorter-range forces between ion and solvent or between ion and ion; but though data have continued to be accumulated, their interpretation has been dependent on advances in our understanding of the nature of liquids.

In this book by the late Dr. R. W. Gurney attention is focused on the solvent molecule, and his novel treatment leads him to some very interesting and suggestive conclusions. Picture a group of water molecules arranged in the open liquid structure. The central molecule will have four nearest neighbours tetrahedrally arranged, two with protons directed towards negative regions of the central molecule and two with the opposite orientation. Outer molecules of the group will contribute to the stability of this arrangement. If now the central molecule is replaced by an atom of nearly equal size on which we imagine an electrical charge of gradually increasing magnitude to accumulate, the state of lowest potential energy will eventually be one in which the four water molecules in contact with the ion each has a proton pointing towards it, if the charge is negative, and vice versa if it is positive. But before the ionic charge has become large enough to impose this arrangement, it must have passed through a critical value for which there is no preferred direction of the adjacent molecules. Gurney considers that this critical value is only a little less than the electronic charge itself, so that rather large univalent ions, like the cæsium and bromide ions, will produce disorder in the solvent surrounding them, whereas small or multiply-charged ions will be able to set up around themselves a new arrangement of local order more stable than that existing in pure water.

As a primary criterion of the order–disorder situation, Gurney uses the viscosity coefficients of the ions. Wolfenden and his collaborators pointed out many years ago a correlation between these viscosity coefficients and the temperature coefficients of the ionic mobilities; for example, at ordinary temperatures the cæsium ion, which has a relatively high mobility and low temperature coefficient, reduces the viscosity of water, and all these effects can be attributed to a loosening of the water structure. Gurney takes this further, and shows a striking relation between the viscosity coefficients and the entropies of solution, and, finally, a correlation between the activity coefficients of uni-univalent electrolytes and the order-producing or order-destroying characteristics of their constituent ions.

Dr. Gurney does not give a discussion of ion-pair formation, but here, too, his methods are suggestive. The experimental dissociation constants derived by semi-empirical methods for such electrolytes as cæsium chloride have for long been regarded as 'impossible' by many physical chemists because (*a*) quantum-mechanical forces will be absent, and (*b*) Bjerrum's electrostatic treatment predicts no association between such large ions in water. The reply to this argument has been that an electrostatic theory using the normal dielectric constant of water cannot give quantitative results for ions at their minimum distance of separation; and this is given substance by Gurney's picture of conditions in the co-sphere of solvent surrounding each ion. As these overlap, the resulting free energy change is equivalent to a substantial short-range force of attraction (or repulsion) between the ions, in terms of which the ion-pair may be more sharply defined.

These comments by no means exhaust the topics to which this book supplies a fresh approach. Everyone interested in the dissociation constants of weak acids should read the treatment of acid-base equilibria, in which again the importance of the entropies in water of the anions is emphasized; and readers, whether they agree with everything said or not, will find the whole book stimulating and provocative.

C. W. Davies

Introduction to Elliptic Functions, with Applications

By F. Bowman. Pp. 115. (London: English Universities Press, Ltd., 1953.) 12*s*. 6*d*. net.

THIS book is for the use of physicists or engineers who desire a knowledge of those properties of elliptic functions which are useful in applications. It deals only with the Jacobian functions; the Weierstrassian functions are excluded. The first chapter shows how ordinary trigonometrical functions can be derived from the inversion of a definite integral, and how a similar procedure leads to the Jacobian elliptic functions, the properties of which for a real variable are then deduced. The second chapter deals with elliptic integrals of the first, second and third kind. The third chapter gives applications to geometry, dynamics, spherical trigonometry and potential. The fourth chapter again uses the analogy with trigonometry to deal with the case of complex variables.

Then follow no less than four chapters on the theory and applications of conformal transformation of elliptic functions and integrals. The applications include hydrodynamics, using the Schwarz–Christoffel transformation, electricity and magnetism. It is rather surprising to see Landen's transformation, a purely mathematical result, deduced from a physical problem. The ninth chapter shows how an integral, the integrand of which is the reciprocal of the square root of a quartic, can be reduced to the standard forms discussed in the second chapter. The tenth and last chapter is more difficult than the rest of the book; it deals with the rather heavy reduction of a certain degenerate hyperelliptic integral, and applies the result to a problem concerning an electric condenser.

The book concludes with a bibliography of textbooks and numerical tables, lists of formulæ and an index. A valuable feature is the large number of examples. The book should be found very useful.

H. T. H. Piaggio

Jiří Procházka: Úvaho o Funkcich Nervové Soustavy

(Georgius Prochaska: De Functionibus Systematis Nervosi Commentatio). Edited by M. Petrán and E. Gutmann. (Prague: Academia Scientiarum Bohemoslovenica, 1954.)

GEORGE PROCHASKA (1749–1820), successively professor of physiology at Prague and Vienna, is now recognized as one of the most important pioneers of our knowledge of reflex action. He introduced the concept of the *sensorium commune* within the central nervous system, impressions conveyed in the sensory nerves being 'reflected' there upon the motor nerves. He was also the discoverer of the olivary bodies and foreshadowed several later neurological generalizations. His great work on the functions of the nervous system, written in Latin, "De Functionibus Systematis Nervosi Commentatio" (Prague, 1784), has now been reproduced in facsimile by Dr. M. Petrán and Dr. E. Gutmann, together with a Czech translation and introduction, and abundant notes. Their book is in typography and lay-out of high standard, and quite worthy of the historical achievements which it commemorates and expounds. Indeed, it constitutes a model for such productions, for it is equipped with an exhaustive index and an admirable biographical glossary of the outstanding physiological writers and research workers of Prochaska's own time and the preceding period. The only regret that can be voiced is that the excellent introduction was not given in one of the Western 'congress' languages as well as in the Bohemian tongue. But it is good to see such honour paid to one of the greatest forerunners of Setchenov, Pavlov and Sherrington.

Joseph Needham

An Introduction to Pathology

By Prof. G. Payling Wright. Second edition. Pp. xii+636. (London: Longmans, Green and Co., Ltd., 1954.) 40*s*. net.

THE period following the outbreak of the Second World War was marked by a gradual change in the approach to several of the basic medical sciences. Pathology ceased to be based largely on morphology, and it came increasingly to be regarded as a subject which should be approached from the functional point of view. Many years ago Sir Michael Foster said that the science of meteorology could not be divided into the science of good weather and the science of bad weather, but the full significance of his remark was long unheeded by pathologists. This excellent work by Prof. G. Payling Wright was perhaps the first book on general pathology to follow this method to its logical conclusion. First published in 1950, it was reprinted twice. The new second edition includes additional chapters on the general manifestations of allergy and on the effects of ionizing radiations.

This work is an ideal introduction to clinical work, since it is based throughout on the etiological and functional approach. A third of the book is devoted to tumours, and the large sections on the causation of new growths is a masterly discussion of an enormous field. The usefulness of the book is enhanced by the historical treatment of the subjects, and the references which were given in the first edition have been increased. This popular work is a real inducement to the student to carry his reading further.

Science and its Background

By Dr. H. D. Anthony. Second edition. Pp. ix+337. (London: Macmillan and Co., Ltd.; New York: St. Martin's Press, 1954.) 20*s*. net.

A SECOND edition of Dr. Anthony's useful book is welcomed, and it is pleasing to know that the work has had such a wide vogue already. To his short and readable account of the history of human affairs as they have been modified by man's increasing knowledge and use of natural phenomena, the author has added two additional chapters. In the first he discusses the post-war utilization of scientific developments, and in the second, the pursuit of science for its own sake.

Clerk Maxwell's optimistic inaugural address as Cavendish professor, in 1871, is more than ever in need of fulfilment—"the popularization of scientific doctrines is producing as great an alteration in the mental state of society as the material applications of science are effecting in its outward mental life". For this Dr. Anthony's book, which is free from the political bias which has marred more pretentious works, is a good introduction.

It is a pity that the second edition had to go to press before the Piltdown hoax had been fully exposed, and another dawn had broken upon *Eoanthropus*! But if the very elect were deceived for so long a time, the interpreter of their works and ideas can scarcely be blamed.

There is a photograph of the Leaning Tower of Pisa to illustrate the account of Galileo's weight-dropping experiment. It would be interesting to try to find the origin of the Leaning Tower legend.

W. L. Sumner

THE METEOROLOGICAL OFFICE, 1855–1955

By Sir GRAHAM SUTTON, C.B.E., F.R.S.
Director

THE State meteorological service of Great Britain came into being in 1855 as the Meteorological Department of the Board of Trade, with Admiral Robert FitzRoy in charge. The word 'Office' was not used until 1863. The primary duty of the new Department was to collect observations on weather and ocean currents for the benefit of shipping. The possibility of scientific weather forecasts, as distinct from the traditional lore of the seaman and the farmer, had been realized for some time before FitzRoy took up his duties, and simple weather maps had been shown in the Great Exhibition of 1851 as an illustration of the potentialities of the telegraph. In 1860 FitzRoy, with Le Verrier of Paris, began the regular collection of observations by telegram, and in the following year a storm-warning system for ports was instituted and daily forecasts were supplied to the Press.

Soon after FitzRoy's death in 1865 the storm warnings and daily forecasts were suspended, on the advice of a committee of the Royal Society, on the grounds that the scientific knowledge available was inadequate for the preparation of forecasts. At the request of the Government, the committee assumed control of the Office in 1867, with R. H. Scott as its chief executive officer, a post which he held, under one title or another, until the end of the century. Largely because of the enthusiasm of Sir Francis Galton, the committee equipped seven observatories with instruments for the continuous recording of pressure, temperature, wind and rainfall and began the systematic study of the form and movements of atmospheric disturbances. By 1879 sufficient confidence had been acquired for the resumption of the publication of forecasts; but probably the most significant event of this period was the first of a long series of international conferences for the standardization of methods of making and reporting observations, held in Leipzig in 1872.

From 1877 onwards the official service was controlled by a paid Meteorological Council, the secretary of which acted as director of the Meteorological Office. The service was almost entirely operational and research was left to outside workers.

Influence of Napier Shaw

Scott retired in 1900 and the Meteorological Council invited Dr. (later Sir) Napier Shaw, a well-known Cambridge physicist, to take his place. This was a highly significant choice, and perhaps the most important event in the history of the Office. Shaw not only gave direction and impetus to the scientific aspects of the service, but also began to attract into the Meteorological Office men of real scientific ability, such as Ernest Gold and R. G. K. Lempfert. He also enlisted the aid of W. H. Dines, perhaps the most gifted designer of meteorological instruments that the world has known. Dines was never a member of the staff, but throughout his life remained closely connected with the official service.

The most active period of Shaw's directorship, from 1900 to the outbreak of the First World War, undoubtedly placed the Meteorological Office in the forefront of the meteorological services of the world. Dines's instruments, in particular the pressure-tube anemometer, the balloon meteorograph and the radiometers, provided a wealth of reliable data, and forecasters began to argue more by physical principles and to rely less on analogies with past situations. The philosophy of the science during this period is perhaps best summed up in Shaw's classical book, "Forecasting Weather", first published in 1911. This work (which is much in the tradition of Clark Maxwell's "Heat") is now largely outmoded, but still remains as a delight, not only for the elegance and clarity of the writing but also because of the shrewd blend of fluid dynamics and thermodynamics with the practical business of synoptic analysis for the routine forecast.

Progress, however, was limited because of the lack of the third dimension, and the typical atmospheric disturbance had perforce to be regarded as something taking place in the horizontal plane. Upper winds could be observed only in clear weather, and although the balloon meteorograph had established much of the climatology of the high atmosphere, the success of a sounding depended entirely on the chance of recovering the record intact after the balloon had burst. The forecaster was denied up-to-date knowledge of temperature and humidity except at the surface, for the aeroplane was still in its infancy. Nevertheless, considerable strides were made. Gold's classical study of upper winds brought out forcibly the dominating influence of the geostrophic balance, and the Shaw–Lempfert analysis of the trajectories of air masses laid the foundation for the subsequent Norwegian work on frontal theory.

Administrative Structure

During the First World War, the urgent need for specialized meteorological information led to the formation of separate services for the Navy, Army and Royal Air Force; but in 1920 the Government took the decisive step of uniting the various services under the Air Ministry. This arrangement, which was viewed with misgiving by some meteorologists, continues to the present day, except that the Admiralty retains control of its own Naval Weather Service. The general policy of the Meteorological Office is the responsibility of the Secretary of State for Air, who is advised by the Meteorological Committee, composed of representatives of the Royal Society, British universities and various Government departments. Financial control is exercised by the Air Ministry through the usual Civil Service machinery, but the Director of the Meteorological Office acts directly under the authority of the Permanent Under-Secretary and not through the Air Council. In practice, this means that the Office, although necessarily in close contact with the Royal Air Force, remains a very individual element of the Air Ministry and carries out its primary duty of acting as the State Meteorological Service, with the advantages that accrue from attachment to a large Department of State. At present, the staff number more than 3,000 and Air Ministry estimates for 1955–56 provide nearly £3½ million for meteorology.

Development of Aeronautical Meteorology

In 1920 Sir George Simpson succeeded Sir Napier Shaw as director, a post he held until his retirement in 1938. This period in the history of the Office coincided with the rapid development of aviation. The First World War had seen a great increase in the number of professional meteorologists, the most notable accession being Captain (now Sir David) Brunt, who became superintendent of Army Services, a post which fortunately allowed him opportunity to engage in the researches which have since made his name famous. Against this must be set the loss of L. F. Richardson, who resigned from the post of superintendent of Eskdalemuir Observatory (the geophysical observatories of Kew and Eskdalemuir had passed from the control of the National Physical Laboratory to the Meteorological Office in 1910) on conscientious grounds, but not before he had sown the seeds of 'numerical forecasting' by his work on the integration of the equations of atmospheric motion. Nearly thirty years had to elapse before the invention of the electronic digital computer made this concept practicable for operational forecasting.

Under Simpson, the Office developed into an efficient technological organization, especially well adapted to serve the ever-growing needs of aviation, both military and civil. Despite the fact that research was not organized on any large scale within the Office, but was left to the efforts of individual workers, the period between the Wars was one of great scientific activity. Forecasting received its greatest forward impulse in the development of the Bjerknes polar-front methods of analysis, and Simpson and Scrase did much valuable work on the structure of thunderstorms. At Porton, N. K. Johnson (who later succeeded Simpson as director), working largely under the guidance of Brunt, laid the foundations of micrometeorology. The greatest advances, however, were in the field of instrumentation, the most significant feature being the application of telemetering techniques to the measurement of winds, pressure, temperature and humidity by free balloons equipped with small radio transmitters. For the first time, the properties of the atmosphere could be recorded as the balloon ascended, regardless of the presence of cloud. This in turn meant that the structure of the atmosphere in depth became known to the forecaster in time for him to include these factors in his analysis.

The Second World War and Afterwards

Sir George Simpson retired in 1938 and was succeeded by Sir Nelson Johnson. The necessity of a research organization within the Office was recognized by the appointment of an assistant director to supervise investigational work, but any further plans were disrupted by the outbreak of war. During the next six years the demands for operational forecasts became enormous, and the staff was increased tenfold to a maximum of about six thousand by the recruitment and training of scientists from other professions. The technique of forecasting changed as upper-air data became more abundant, and the idea of studying the absolute and relative topographies of surfaces of constant pressure gradually became established. In 1942 the Meteorological Research Committee was formed and has continued in being ever since. It has three sub-committees which maintain an active interest in all the research activities of the Office. The sub-committees deal on the average with some forty or so 'Meteorological Research Papers' every year, most of which are original contributions by members of the staff. The same year saw the formation of the Meteorological Research Flight, which operates from the Royal Aircraft Establishment, Farnborough, and has provided much reliable information on the structure of the high atmosphere, especially in relation to its water vapour content.

Sir Nelson Johnson retired in 1953 and I was appointed to succeed him.

At the present time the Office operates under the director, the principal deputy director (Dr. J. M. Stagg), and three deputy directors in charge of forecasting (Mr. S. P. Peters), services (Dr. A. C. Best) and research (Dr. R. C. Sutcliffe), respectively. The research activities of the Meteorological Office now cover a very wide field and it is possible to mention here only a few of the more prominent items. The advent of the high-speed computer has directed attention to the possibility of forecasting the development of the pressure field over a limited area by the step-by-step integration of the hydrodynamical equations. This concept was first introduced by L. F. Richardson in 1922; but the modern approach arises more from the work of C. G. Rossby on long waves and the pioneer studies of R. C. Sutcliffe on the relation between vorticity and cyclonic development. These ideas have been applied to simple atmospheric models by a number of workers, chiefly Charney and Thomson in America, and Sawyer and Bushby in Britain. In this way predictions of the pressure field for the next 24–48 hr. can be made in a time sufficiently brief for the forecast to be used operationally. So far, the method has not been taken beyond the research stage, but enough has been done to show that there are considerable potentialities in this approach. On the other hand, little or no success has been achieved with forecasts for longer periods, and the problem of predicting the general nature of, say, the next winter remains as baffling as ever. In the field of instrumentation, the Dobson–Brewer frost-point hygrometer has been developed successfully for use by the Meteorological Research Flight, and the final stages in the production of a new radar-sonde equipment, capable of exploring the atmosphere to heights of the order of 100,000 ft., are in sight. This equipment, the most advanced in the world, has been developed jointly by the Instrument Division of the Meteorological Office, the Radar Research Establishment (Malvern) and Messrs. Mullard, Ltd.

On the operational side, the key station is the Central Forecasting Office, Dunstable, which collects information from all parts of the world and redistributes it to local forecasters at military and civil aerodromes throughout Britain. Climatological work is concentrated at Harrow, where an expert advisory service is maintained to meet the needs of industry, transport and the public generally. Broadcasting has become the principal means whereby the forecasts reach the public, and the Office supplies a team of forecasters to the B.B.C. Television Service for this purpose. An automatic telephone service for the London area is soon to come into operation—at the present time the forecast office at Kingsway, London, has to deal with about 80,000 telephone inquiries annually.

No account of the Meteorological Office, however brief, should omit a reference to international

activities. During the hundred years of its existence, the Office has played a large part in fostering international co-operation in meteorology, and the late Sir Nelson Johnson was president of the International Meteorological Organization during the critical post-war period when the Organization handed over its responsibilities to the World Meteorological Organization, one of the Specialized Agencies of the United Nations. The staff of the Office take a large part in the activities of the World Meteorological Organization, especially in relation to its technical commissions, and the meteorologist has to accept foreign travel as an integral part of his official duties.

The greatest handicap from which the Meteorological Office has suffered during its first hundred years has been the neglect of meteorology as a subject for systematic study by British universities generally; but there are now welcome signs of an awakening of interest. The Office has placed research contracts with the universities of Oxford, Cambridge, London and Wales (University College, Aberystwyth), and has stimulated interest in the science by inviting members of university staffs to serve on the Meteorological Research Committee. The need for basic study is, however, pressing, and although the Office has now a large and well-developed research side, backed by one of the finest collections of meteorological literature in the world, the professional meteorologist requires more than ever the support of the academic worker to help him to grapple effectively with the many problems that await solution.

THE GOVERNMENT LABORATORY POLONIUM SERVICE

IN April 1930, Dr. (now Sir George) G. C. Simpson, then director of the Meteorological Office (Air Ministry), approached Sir Robert Robertson, who was Government Chemist at the time, with the request that the Government Chemist's Department should undertake the polonium plating of the 'collectors' of the instruments used for measuring atmospheric potential gradient at the observatories at Kew, Eskdalemuir, Dumfriesshire and Lerwick, Shetland.

The 'collectors' are copper rods, 3 in. long tapped to a 2.B.A. thread at one end, and they are plated with polonium for about half an inch at the other end. The originals were supplied by the Meteorological Office, but replacements have since been made in the Government Laboratory workshop. Experimental work has also been carried out with a split collector, plated over a narrow band in the middle of a cylinder 2 in. long, and $\frac{3}{4}$ in. in diameter, that is made in two pieces for clipping on to a wire. In use, the standard type of collector is screwed to a rod projecting from the wall of a building, the rod being connected to the needle of a quadrant-type electrometer.

The record is standardized by measurements over open level ground. Before the introduction of the polonium-coated type, Kelvin 'water drop' electrodes were used at Kew and Eskdalemuir, and a spiral wire coated with a preparation containing radium at Lerwick. Potential gradient measurements have been made at Kew since about 1840, and the record is tabulated since 1898. The quadrant electrometer in use at present was set up in 1886; it is a slight modification of a very early model installed personally by Lord Kelvin in 1873.

Prof. Sidney Russ, of the Middlesex Hospital, supplied the Government Chemist's Department with used radon tubes, and from them Mr. C. O. Harvey prepared the plating solutions as radium D, E and F in $N/2$ (5 per cent) hydrochloric acid; though since 1935 the solutions have been made up in 0·15 N (1 per cent) nitric acid, which was found to be more satisfactory. On May 9, 1930, the first collector was dispatched to Kew Observatory, and since then more than four hundred collectors have been sent to the observatories at Kew, Lerwick and Eskdalemuir. The work, originally in the care of Mr. Harvey, has since been performed by Mr. J. L. Buchan, Dr. P. J. Hardwick, Dr. C. R. Hoskins and Mr. A. D. Baynes-Cope in succession.

The techniques used are kept as simple as possible. Plating is by autodeposition, during 24 hr., from a magnetically stirred solution. Each of the six solutions used contains about $\frac{1}{2}$ mc. of radium D and is used about once every three months, allowing ample time for polonium to be regenerated from the radium D. Copper accumulates in the solutions, and is removed every two years.

The service was not interrupted in any way by the Second World War, and the only recorded mishap came in January 1953, when the collector in use at Lerwick was blown away in a blizzard. A fresh collector was dispatched within twenty-four hours, and later, the collector was recovered, bent but still active and serviceable.

During 1954, information on the length of useful service was obtained from the observatories, and experimental data were obtained in the Government Chemist's Department. It was found that the loss of efficiency in collectors was due more to adverse weather conditions than to normal radioactive decay processes. The fog of December 1952 almost completely deactivated the collector at Kew, whereas in fine weather in the spring in 1954 the Lerwick collector lost only a little more than the theoretical amount of activity.

This account is published by permission of the Government Chemist, Dr. G. M. Bennett.

DEPARTMENT OF SCIENTIFIC AND INDUSTRIAL RESEARCH

REPORT FOR 1953–54

IF the persistence with which questions have been asked in the House of Commons in recent months concerning the Department of Scientific and Industrial Research is any guide, the Department's report for the year 1953–54* should be received with exceptional interest. It includes a short report of the Committee of the Privy Council, over Lord Salisbury's signature, and the thirty-ninth annual report of the Advisory Council, signed by Sir Hugh Beaver; there is also the usual summary of work carried out by the various research stations and boards and research associations—in fact, the report follows the usual pattern of recent years. Besides a summary of the Department's expenditure for the

* Department of Scientific and Industrial Research. Report for the year 1953–54. (Cmd. 9386.) Pp. 326. (London: H.M. Stationery Office, 1955.) 9s. net.

year ended March 31, 1954, there are appended lists of assessors to the Advisory Council, of the various committees of the Advisory Council, research boards of the Department and their membership, of grants for special researches in progress or authorized during the year and a 27-page list of publications issued during the year.

There is thus much useful material in its three hundred odd pages to assist either a member of Parliament or of the general public to form a sound opinion as to the value the nation is getting for an expenditure of £5,865,279 in 1953–54 and for which £6·5 million is provided in the Civil Estimates for 1955–56. Nevertheless, as questions being asked in Parliament indicate, the report does not really provide the background information by which the soundness of the distribution of Britain's effort in this field as a whole can be judged. The Department's expenditure of £6 million has to be set against a figure of £200 million or more on civil research in the Civil Estimates; nor does this figure take account of expenditure by industry on like purposes, of defence research, which may have relation to civil needs, or of that being carried out by the public corporations. The absence of any such broad background information means that judgment on particular items of expenditure by the Department must be made with reserve. Nor is there evidence that any steps are being taken to improve the clumsy and indirect arrangement by which questions regarding the Department's activities are handled in the House of Commons, to provide the Lord President of the Council with an adequate staff, or to strengthen the Department's Intelligence and Information Division sufficiently to enable it to deal adequately with the matter of public relations, neglect of which appears to be responsible for a considerable proportion of Parliamentary questions.

The gross expenditure of £5,865,279 compares with £5,773,303 gross in the previous year and is reduced to £5,254,342 by various receipts (£317,970 being by the National Physical Laboratory) for work done for other government departments or for industry, the net increase on 1952–53 being £46,887; the estimates for 1954–55, as approved, provide for a further increase of £578,379. On October 1, 1954, the Department employed 4,220 staff of all grades (including 164 part-time), compared with 4,073 (159 part-time) the previous year. Annual grants to research associations totalled £1,254,088 (compared with £1,449,635 in 1952–53), with a special grant of £1,839 and grants for special researches amounting to £412,431 (£317,321 in 1952–53). Grants to students amounted to £295,419, an increase of £29,522, the number of students in training being 1,009 compared with 976, and of these 415 were new. Of the eleven senior research awards, four were new, and 26 new grants for special researches brought the total of such grants to 58, compared with 70 in 1952–53 and 91 in 1951–52. Six of these awards were in physics, three in chemistry and one each in biology and engineering; and of the grants for special investigations, twenty-five were in physics, seventeen in chemistry and four each in mathematics and astronomy, in biology and in engineering. Chemistry claimed 427 and physics 300 of the students receiving grants; 99 were in engineering, 97 in biology, 38 in mathematics and astronomy, 32 in geology and 16 in metallurgy.

Expenditure of £831,019 gross or £513,049 net on the National Physical Laboratory was slightly less than in 1952–53 (£546,617 net). Expenditure of £314,407 on mechanical engineering was £31,750 less than in 1952–53; but although net expenditure on building research (£411,594), fire research (£25,355) and forest products research (£101,252) was also less than in the previous year, the decrease was only slight. Expenditure on research contracts, however, decreased from £9,289 to £2,589.

Net expenditure on the Chemical Research Laboratory increased by £10,779 to £124,353, on food investigation by £71,587 to £292,118, on fuel research by £9,292 to £246,984, on the Geological Survey and Museum by £6,601 to £210,732, on hydraulics by £3,886 to £61,562, on pest infestation by £2,121 to £58,757, on radio research by £43,678 to £94,397, on road research by £12,567 to £305,532, and on water pollution by £1,249 to £62,673. Headquarters, administration, etc., accounted for £220,379, compared with £213,119, and £42,483 was provided for European nuclear research.

For the latter purpose, £360,000 was provided in the Estimates for 1954–55, and this has been further increased to £520,000 in the Estimates for 1955–56, so that a considerable proportion of the increase in the Department's estimates over the two years is represented by grants for work outside Great Britain. With Great Britain's expenditure on the Atomic Energy Authority already running at £50 million a year, this addition needs to be remembered in considering the allocation of scientific effort, while of the Department's grants of £400,000 for special researches, some £300,000 a year is for support of nuclear physics research in universities. For this latter purpose the Advisory Council has now constituted the Nuclear Physics Sub-Committee of its Scientific Grants Committee as a full committee, the terms of reference of which include, besides the consideration of applications for grants, the keeping under review of the scientific aspects of the Department's responsibilities arising from the United Kingdom's membership of the European Organization for Nuclear Research.

Government Establishments

The Advisory Council now reports substantial progress in the building of the new Mechanical Engineering Research Laboratory at East Kilbride, where the hydraulic machinery laboratory is approaching completion and new laboratories for the Divisions of Heat, Mechanisms and Metrology are likely to be started soon. The non-industrial staff is now 190, an increase of 25 per cent during the year, and recruitment of a further 40 has been authorized. In the Divisions of Mechanics and Materials, loads and stresses occurring in engineering components in service and the way materials behave when subject to these stresses are being determined by analytical or experimental methods, so that more efficient use can be made of existing and new engineering materials. The emphasis is on repeated loading, that is, fatigue, and on materials for use at high temperatures, including the continuous deformation of metals under steady loads. In the Fluid Mechanics Division modern knowledge of fluid dynamics, especially that gained in aerodynamics research, is being applied to mechanical engineering problems, for example, with the view of improving the efficiency of water-turbines, pumps and other hydraulic machinery. In a fourth Division, the study of the fundamental causes of friction and wear between rubbing surfaces and of techniques for their reduction in machinery has con-

tinued. Electron microscope examination indicated that unused lubricating oils for diesel engines containing 'heavy-duty' additives were true solutions. Tests in which the flow of lubricant through a high-speed bearing has been followed by using a transparent outer bearing shell and introducing a fluorescent dye excited by ultra-violet light into the oil indicate the need for special care in designing the passages by which oil is introduced into the bearing. Basic components of mechanisms, such as gears, ball-bearings and universal joints, are being studied in the Division of Mechanisms and Metrology, to improve their operation and reduce noise, while the Plasticity Division is seeking a fuller understanding of the fundamental mechanism of plastic flow which should facilitate more efficient use of materials, more exact and economical design of machinery and a saving in power. The Division of Heat Transfer and Thermodynamic Tables is endeavouring to increase the efficiency of heat transfer equipment, including boilers, condensers, heat exchangers and many types of chemical engineering plant, and is preparing tables of thermodynamic properties of working fluids used in engineering, correlating and co-ordinating data from various sources. The Mechanical Engineering Research Laboratory was one of the Department's establishments visited by the Advisory Council during the past year.

At the Building Research Station, which was also visited by the Advisory Council, full-scale trials were carried out in conjunction with the National Federation of Building Trades Employers of the use of air-entrained sand–cement mixes for external renderings and internal undercoats to plaster, and of the use of zinc oxychloride paint as an additional means of preventing the spread of dry-rot in timber. Research on prestressed concrete continued with particular reference to the investigation of fire resistance in collaboration with the Joint Fire Research Organization, and it is now clear that sufficient protection can be given to prestressed concrete to allow its use in large structures where fire resistance is important. Results of an investigation, carried out in collaboration with the Metropolitan Water Board, indicate the possibility of dispensing with expensive steel lining in a proposed new deep-water tunnel some twenty-six miles long, with large savings in money. A major stage was completed in the investigation of single-stack plumbing, and design rules were published applicable to flats of up to five stories, which offer savings of 40–50 per cent in the cost of the pipe-work over conventional plumbing arrangements. The extensive site trials carried out with the use of rail-mounted tower cranes for two- and three-story buildings show that a considerable reduction of building costs can be expected on most sites. Good progress has been made in the study of alternative methods of house-construction using factory-made components and dry-finished interiors.

The Fuel Research Station was also visited by the Advisory Council during the year and the problems of this Station are receiving particular attention. The Advisory Council believes that the Station is still of high importance as a national centre for the study of fuel problems, and an immediate increase in staff has been recommended to accelerate work on atmospheric pollution and domestic heating. Experimental work on the gasification of coal fines with steam by the fluidized-solids technique continued, and increasing attention is being given to the flow properties of residual fuel oils, where more fundamental knowledge is required if a satisfactory test, applicable to all types of residual fuel oils, is to be evolved. The radioactive tracer technique has been used to investigate the mechanism of formation of the alkali sulphates responsible for bonded deposits in boilers, and further development work has been carried out on different types of combustion chamber for burning solid fuel in industrial gas turbines. The facilities of the Calorimeter Building are fully occupied in the study of the heat distribution from various types of domestic heating appliance, and a new and improved instrument for recording and measuring domestic smoke has been developed.

Special reference is made in the Advisory Council's report to the work of the Road Research Laboratory and of the Food Investigation Organization. In the field of safety, the former has been concerned with the properties of toughened glass for windscreens, the construction of protective helmets of motor-cyclists and the value of yellow head-light beams, while the Laboratory's work on dazzle indicates that a great improvement in visibility could be obtained by improved setting of vehicle head-lamps. Several machines for spreading cement and mixing it into soil as a road basis, developed with the Laboratory's help, are now in production, and attempts are being made to isolate and identify the organic constituent in certain sandy soils which prevents the setting of cement; the results have now been published of a study of the rheological properties of a wide range of fine mineral powders when mixed with bituminous liquids, as part of an extensive investigation of the mechanical properties of dense bituminous mixtures used for surfacing roads.

The Food Investigation Organization comprises a headquarters in Cambridge and four divisions dealing, respectively, with biochemistry and biophysics; meat and meat products; fish and fish products; and fruit and vegetables. The Advisory Council is satisfied that the arrangements for liaison with the many other organizations concerned with such problems are satisfactory, but it has established, as an experiment, a standing consultative committee on food research, representative of all the various sections concerned, including the research associations. The work on frozen beef has shown that it is impracticable to freeze sides of beef before *rigor mortis* sets in; there is little danger that the use of blast tunnel freezers would damage beef by freezing it before the occurrence of *rigor mortis*, but it has yet to be shown that such early freezing is desirable. A specially designed diesel-electric trawler is being built to meet the research needs of the Torry Research Station, and it is also planned to install plant to freeze the first part of the catch on an existing Arctic trawler and to operate the vessel for twelve months. Studies have been made of the effects of the procedure used for freezing at sea on the quality of the fish. A major problem in the storage of home-grown apples is to reduce the amount of lenticel rotting, caused by *Gloeosporium* species, of Cox's orange pippins stored beyond Christmas. The types of canker and die-back produced on apple trees by this species have been identified, and inoculation experiments indicate that twigs of Cox's orange pippin trees are affected more rapidly than twigs of Bramley's seedling. Losses during storage are also caused by physiological changes within the fruit itself, one of the most troublesome being scald. It is now clear that exceptionally fine summers are more likely to

produce fruit susceptible to scald than are normal English summers, and that the earlier the fruit is picked, the greater the risk of scald: with early-picked apples the only satisfactory way of preventing scald is to wrap the fruit in oiled paper. Measurements are also being made of the loss of water from apples in commercial stores. Investigations of the phenolic constituents of plants have shown that the leuco-anthocyanins make an important contribution to astringency in cacao products, wines, fruits and fruit juices. Studies are being made on a semi-technical scale of the economic possibilities of ion-exchange processes for the preparation of ascorbic acid and other useful constituents from forage plants, and the route of synthesis of ascorbic acid from simple sugars has been discovered and effected enzymically *in vitro*.

The account of the work of these research establishments of the Department occupies some 80 pages of the report, and a further 115 are devoted to the work of the research associations. Only a few additional examples can be given to illustrate the range and magnitude of the Department's contribution to the national welfare. The work of the National Physical Laboratory and of the Chemical Research Laboratory has recently been reviewed in these columns. No more need be added here than that the Advisory Council directs attention to the formation at the former of a new Division for Electronics and Control Mechanisms, with a small group for studying the possibilities of increasing the mechanization of large-scale office work. This, it is believed, may make a major contribution to economy in the use of man-power. The Council also commends the two symposia, dealing with "Automatic Digital Computation" and "Engineering Dimensional Metrology", held at the Laboratory in 1953, as a valuable means of disseminating knowledge of the Laboratory's work and fostering the interchange of ideas with scientists and technologists outside the Department.

The Joint Fire Research Organization is to study reports of large fires in general, since these account for a high proportion of fire losses, and in the textile, dyeing, bleaching and finishing trades these major losses are associated with fires occurring outside working hours. Data for the design of explosion relief vents are being steadily accumulated, and basic studies have been made of the propagation of flame in dusts with the view of developing an improved test for measuring the explosion hazard of dust-laden atmospheres.

The demand for industrial information and advice from the Forest Products Research Laboratory remains high, and routine testing of new Colonial timbers is still a major project. Investigations have continued on the boring of quarter-sawn and flat-sawn material from various species, the torque and thrust being measured at different spindle- and feed-speeds. Service trials on railway sleepers begun in 1935 are nearing completion, and in the work on timber-rotting fungi attention has been given chiefly to the physiology of the group of Ascomycete fungi which give rise to 'soft rot'. Studies on the biology of the common furniture beetle are continuing, particularly on the effect of decay on the attack of the beetle.

The field-staff of the Geological Survey was engaged principally upon primary and revision six-inch mapping, 295 sq. miles being surveyed in 1953, priority in choice of ground being governed largely by economic considerations. Accounts have also been prepared of English rocks collected during current field surveys and from boreholes drilled for economic minerals, including coal and potash. Two types of investigation by boring have been undertaken: the first to ascertain by deep boreholes the nature and distribution of the rocks lying some distance below the surface, and the second to amplify and extend the findings of mapping. Gravity surveying was continued in the English Midlands, and also the survey of the water resources of the Triassic Sandstone area there, as well as researches directed towards the discovery of new sources of raw materials for atomic energy installations.

Satisfactory progress is reported with the construction of the first stage of the main hall of the new Hydraulics Research Station. Investigation in the large model of the Thames Estuary of the heavy siltation occurring in the tidal basin at Tilbury has shown that certain training works would greatly reduce the inflow of silt-laden water and thus reduce the dredging required. Recommendations for remedial works based on these experiments have been submitted to the Port of London Authority. Other research has been concerned with the effect of sea-walls on beaches, and a mobile-bed model of Southwold Harbour, Suffolk, has been constructed to examine various means of reducing wave action in the harbour and the effect of these works and of proposed repairs and alterations to the harbour arms on littoral drift and siltation. A rigid-bed model has also been constructed for the investigation of a flood relief scheme proposed for the River Severn in the neighbourhood of Shrewsbury.

Pest infestation research continued on the same main lines as in the previous year, but the work on the infestation of slaughter-houses by blowflies and the study of the interaction of wheat protein with methyl bromide were completed. Considerable progress was made in the basic physiological research underlying the study of the mechanism of insecticidal action. The work on the hermetic storage of damp grain has aroused considerable interest, while investigations on the control of bean weevils indicate that admixture with each 200 lb. of beans of 6 oz. of a diatomite powder containing 0·05 per cent of gamma-benzene hexachloride ensures freedom from infestation if the insecticide is applied sufficiently early after harvesting. Continued experiments have shown that even heavy infestations by Pharaoh's ant, *Monomorium pharaonis*, in hospitals can be controlled by systematic application of chlordane, and a study of the practical control of the cacao moth in a London warehouse has been started.

The work of the Radio Research Organization has continued to be mainly concerned with wave-propagation; but it also includes semi-conductor research, particularly directed to understanding the physical processes occurring in point-contact and junction components and how these are related to their electrical behaviour. Work carried out at universities under contract from the Department includes very-low-frequency ionospheric research at the Cavendish Laboratory, Cambridge, high-frequency ionospheric research at University College, Swansea, work on transmission characteristics of surface waves at University College, London, and on dispersive artificial dielectrics and on ferromagnetic and ferroelectric materials at the Imperial College of Science and Technology, London. The new Water Pollution Research Laboratory at Stevenage was completed during the year, and the Laboratory has investigated the removal of certain radioisotopes

from water by processes normally used at water-treatment plants. Work on the biological filtration of sewage has confirmed the importance of periodicity of dosing in determining the efficiency of a filter; it has now been found that percolating filters can break down cyanides when these are supplied as solutions of potassium, zinc or cadmium cyanides in concentrations up to 160 parts of hydrogen cyanide per million. In an investigation on the effect on the River Colne, near Watford, of the discharge of effluent from a modern sewage treatment works, an attempt is being made to correlate the distribution of fish in the effluent channel with the chemical characteristics of the effluent. The survey of the Thames estuary is now mainly concerned with the factors affecting the oxygen balance in the estuary.

(To be continued)

THE PAINT RESEARCH STATION, TEDDINGTON

OPEN DAYS

THE Paint Research Station at Teddington was opened to visitors during May 2–7. Most research institutes have such occasions, which call for good planning and showmanship if past achievements and future trends are to be adequately demonstrated. These qualities are not always integrated in research workers, but the director of the Station, Dr. L. A. Jordan, and indeed all the staff concerned, are to be congratulated on a most admirable presentation of their work, which undoubtedly had an impact of consequence on those attending, some 750 in all.

The subjects studied at the Station fall naturally into four broad divisions: media, pigments, paint manufacture, and paint utilization. As the visitors passed into the various rooms they were met by experts prepared to explain and expound the subjects under study or the apparatus on show. In addition to receiving the general laboratory guide, visitors were able to read and collect brief statements detailing the work dealt with in each room. There were fifty or more of these papers and some necessarily ran to four quarto pages. The scientific detail thus made available was considerable, and its practical objective was brought into focus by a short preface to each paper.

The appreciation by visitors of the inter-relations between the demonstrations in various laboratories and their setting was greatly assisted by short talks lasting not more than 20–30 min. given at intervals throughout the days. This arrangement fully achieved its object and, moreover, was a factor in preventing physical fatigue. The subjects were: (*a*) atomic energy, drying oils and the future; (*b*) alkyd resins research; (*c*) synthetic resin emulsion paints, their structure and properties; (*d*) accelerated weathering studies. A film prepared under the direction of the staff was also shown more or less continuously entitled "Benard Cell Effects in Paints". A good alternative title would have been "the study of pigment flotation in paints and its control by the use of silicone oils". This was particularly interesting and intriguing, dealing with special features of a type of phenomenon with wide manifestations in Nature.

To-day paints are manufactured from a variety of new media, as well as from traditional materials, and provide an ever-increasing scope for study. Tracer techniques are widely employed, and the Research Station now has its own source of γ-radiation whereby the study of various polymerizations and other reactions in drying oils and related materials is proceeding apace.

The alkyd resin concept as it has come to fruition in the production of paint media of admirable quality is still a comparatively recent matter; by contrast, the heat-treatment processing of drying oils, such as linseed oil, tung oil and some others, is almost as old as paint itself. In these fields of work the Research Station continues to make an outstanding contribution, now assuming added importance since Prof. T. P. Hilditch is no longer at work at Liverpool.

Measurements of molecular weights necessarily enter into many of these studies. The methods employed involve measurements of osmotic pressure, boiling point, light-scattering effects and viscosity. By the use of new membranes such as those prepared from polyvinyl alcohol, the lower limit of molecular weight determinable by osmometry has been brought down to about 1,000.

Film formation from a variety of media has been studied by measurements of oxygen uptake and by examination of the products formed. Part of this study is concerned with the drying of films under adverse conditions, such as industrial pollution, tropical humidity or low temperatures.

Linoleum manufacture is akin to paint manufacture in that it involves the oxidation and polymerization of linseed oil. The chemistry of these changes has been considerably clarified by the application of such techniques as solvent fractionation, molecular distillation, infra-red and ultra-violet spectroscopy.

Colour and opacity form the main basis for the commercial evaluation of many pigments. While the Station must necessarily measure these properties, the work on pigments has been carried much further than is required for mere description. Particle-size, shape and distribution are important factors in pigment studies, and their measurement calls for various physical techniques, of which the most attractive is electron microscopy. The original home-made electron microscope—believed to be the second made in Britain, and in the early days of the War—is still in use. Crystal structure factors are examined by electron diffraction and X-ray analysis. The useful concept of 'specific surface'—the surface area per unit weight of powders—is being brought to its full significance for pigments. The values obtained vary from 20–900 sq. m. per gm. for carbon black to 0·5–2·0 sq. m. per gm. for barytes. The wetting and dispersion characteristics of pigments also have not been neglected.

Synthetic resin latex paints are a fairly recent introduction to the industry. To-day their use is widespread and well established; the medium employed consists of a highly viscous dispersed material in the form of swollen particles, and its study calls for new methods of approach involving problems in rheology, storage stability, permeability, inflammability and exterior durability. The nature of the pigment distribution, the structure of the film and the effects of plasticizers in such paints have been studied by various methods, including the application of radioactive tracers and the electron microscope.

Paint utilization involves the relationship between the paint film and the surface on which it is applied. Flexibility, hardness, adhesion and other mechanical properties of films are dependent on their molecular

and internal macro structure. Adhesion studies are carried out in gravitational fields produced by specially designed rotor apparatus, and with other equipment. The understanding of adhesion is not easy; both chemical and physical factors are involved, and a condition called mechanical adhesion seems to be dependent on the ability of a paint film to enter grooves and other deformities in the substrate. The Research Station is hopeful of making some new and significant contributions in this field.

Durability of paint in its many uses is the thing that matters to the customer. To anticipate the behaviour of paint in the sense of accurately forecasting its likely behaviour in various environments is still a dream; but the Research Station has for many years put a big effort into the study of accelerated testing procedures. The current approach is to utilize the results of testing the mechanical properties of films (tensile strength, flexibility, creep, recovery, etc.) after various periods of ageing or accelerated weathering, in order to show the trend of change and to interpret its meaning in terms of probable ultimate performance. A very interesting device in this section involves the use of measurements of the velocity of sound through paint films to determine Young's modulus.

In these ageing and durability studies, the electron microscope has proved a valuable tool for detecting changes in paint deterioration long before they become visible to the naked eye. Stains on painted surfaces, mould growth, paint inclusions, paint deposits, and the effects of atmospheric pollution all call for special techniques, many of which involve microchemistry. These specialized analytical methods, including the direct determination of organic oxygen by Unterzaucher's method, the utilization of ion exchange resins and colorimetry are features of the work of the Analytical Chemistry Section at Teddington.

The Library of the Station deserves mention for its unique collection of specialized books and journals dealing with paint, and for the information, loan and abstract review services which have been organized for its members. How much the Paint Research Station is valued by the trade is proved by the fact that members went there on more than four hundred occasions during 1954.

The results of the application of science to the paint industry are about us all to-day in our homes; a short visit to this Station will soon convince anyone that this chapter is not a closed one—only the opening paragraphs have as yet been written.

W. D. R.

ZOOLOGICAL SOCIETY OF LONDON

EXHIBITION OF WHALES AND WHALING

By Dr. L. HARRISON MATTHEWS, F.R.S.
Director

ON May 23 an exhibition of unusual scope was opened by H.E. the Ambassador of Norway, Mr. Preben Prebensen, in the gardens of the Zoological Society of London.

Whales are of great interest to the zoologist by reason of their many peculiarities of structure and ways of life. They are of great economic importance for the valuable products that are obtained from them. But to the general public they are particularly striking by reason of their enormous size. They are the largest mammals in the world and the largest animals that have ever existed. Once or twice in the past the Zoological Society has attempted to exhibit alive the smallest of the whales—the porpoises and dolphins—but it can, of course, never hope to show the larger kinds in captivity. The next best thing is to exhibit accurate replicas, and the Society was therefore delighted to seize the opportunity of showing the impressive model of a sperm whale's head used in making some of the scenes in Moulin Productions' film of Herman Melville's book, "Moby Dick". Around this centrepiece a number of photographs and other exhibits have been grouped to illustrate the natural-history of whales and the history and methods of the whaling industry.

Open-boat whaling for sperm whales began some 250 years ago on the New England coasts of America, and by the middle of the past century no less than 735 American whalers were at sea. Many of these ships completed their crews with sailors from the Portuguese Atlantic islands, the Azores, Madeira and the Cape Verdes. Then there came a decline in sperm whaling after the introduction of paraffin for lighting—a new American industry killed the old one.

But besides the sperm whale there are other great whales—the baleen whales that have no teeth like the sperm whale but instead have numerous plates of whalebone that form a strainer in the mouth which is used for filtering out the shrimp-like krill on which these monsters feed. Their oil, too, is different from sperm oil and can be used for many other purposes, such as making soap and margarine. But they cannot be caught with hand harpoons, for they are extremely active and they sink when dead and would drag down any boat rash enough to harpoon them. They were therefore safe from whalers until about 1860, when the Norwegian Svend Foyn invented the modern whale cannon which is mounted on a small steamship and fires an explosive harpoon that kills the whale. The harpoon is attached to a rope stout enough to haul the dead whale to the surface. The great whaling industry of the Antarctic is based on Svend Foyn's invention and it produces some two million barrels of oil every year.

But the old-time methods are not yet dead; sperm whaling from open boats is still carried on in the Azores and Madeira by men who are the descendants of the Portuguese sailors who learned their trade in the American whale ships more than a century ago.

In addition to the model, which is slightly larger than life size, the exhibition includes an exact replica of a whale boat of the period 1842–48 with all its gear, and a replica of part of the deck of a whale ship of the same period, with the try-works used in boiling the oil out of the blubber. Much historical research has been devoted to obtaining information for use in the construction of these exhibits and every detail is believed to be correct. In contrast to these, a modern whaling cannon and harpoon, and flensing knives, give some idea of the present-day highly organized Antarctic whaling industry.

The photographs show several species of whales, the giant squids that form the food of sperm whales, and the Euphausian 'krill' forming that of the baleen whales. Another series of enlargements shows many stages in the hunting and capture of whales and the utilization of their carcases by the floating factories in the Antarctic. These are set off by a number of

stills from a film showing the hunting and capture of sperm whales from open boats with hand harpoons at the present day off the Azores and Madeira.

The inauguration was assisted by H.E. the Portuguese Ambassador, Dr. Pedro T. Pereira, one of the few diplomatists who has had personal experience of whaling. He is the holder of a coastal master's certificate and is a member of the Portuguese Naval Reserve.

Mr. Preben Prebensen, the Norwegian Ambassador, in declaring the exhibition open, said that he welcomed the opportunity it provided for the public to learn something of a most important industry in which his country took a leading part, an industry of great magnitude of which, however, little detail is known to the vast majority of people.

OBSERVATIONS ON HEAVY MESONS AND HYPERONS

FOR more than two years it has been known that heavy mesons and hyperons exist with a variety of modes of decay, and one of the central problems of the physics of elementary particles has been to establish the details of their properties. A list of transformations which are well established, or for which there is strong evidence, is shown in Table 1. As the work has progressed, it has appeared increasingly important to establish whether or not other differences exist between the properties of heavy mesons decaying in different modes. The existence of a small difference of mass, for example, if it could be established, would exclude the possibility that the particles represent alternative modes of decay of particles of a single type.

Table 1

Modes of decay of heavy mesons

$\tau^{\pm} \rightarrow \pi^{\pm} + \pi^{+} + \pi^{-}$
$\tau'^{+} \rightarrow \pi^{\pm} + (\pi^{0} + \pi^{0})$
$\varkappa^{+} \rightarrow \mu^{+} + 2$ or more neutrals
$\chi^{+} \rightarrow \pi^{+} + \pi^{0}$
$K_{\mu} \rightarrow \mu^{+} + \nu^{0}$
$K_{\beta} \rightarrow \beta^{+} + 2$ or more neutrals
$\theta^{0} \rightarrow \pi^{+} + \pi^{-}$

The mass of the τ-meson is $966 \pm 3\ m_e$, assuming $m_\pi = 273\ m_e$. The masses of particles decaying in the modes θ^0, χ and $\varkappa_\mu$ are equal to m_τ within about $20\ m_e$.

Masses and modes of decay of hyperons

$\Lambda^{0} \rightarrow p + \pi^{-}$ $2{,}181 \pm 1\ m_e$
$\Sigma^{+} \rightarrow p + \pi^{0}$, $\rightarrow n + \pi^{+}$ $2{,}327 \pm 3\ m_e$
$\Sigma^{-} \rightarrow n + \pi^{-}$
$\Xi^{-} \rightarrow \Lambda^{0} + \pi^{-}$ $2{,}540 \pm 30\ m_e$

During this period it has become apparent that, in using the photographic method for such studies, there would be great advantages in employing very large stacks of stripped emulsions. It was believed, for example, that they would permit a large fraction of the secondary particles to be observed to the end of their range, thus giving decisive evidence for the nature of the secondaries. This would permit a determination of the relative frequency of occurrence of different modes. Further, very accurate values of the energy of emission of the secondary particles could be obtained, and for those modes in which there are two secondary particles only, accurate determinations of the mass would follow.

The technical problems involved in processing very large stacks of emulsions—and in making balloon flights with heavy loads at great altitudes—having been overcome, a stack with a volume of 15 litres, mass 62 kgm., was exposed in Northern Italy in early October 1954, in a collaboration between the Universities of Bristol, Milan and Padua. It is referred to as the *G*-stack, and its dimensions—37 cm. × 27 cm. × 15 cm., made up of 250 sheets of emulsion, 600μ thick—were chosen to ensure that a considerable fraction of the secondary particles, even those of range about 20 cm., would be arrested in the stack.

The balloon was launched from Novi Ligure, and floated at an altitude between 85,000 ft. and 78,000 ft. for six hours. During the ascent, it travelled towards the south-west and passed beyond the coast and over the Gulf of Genoa. On reaching its maximum altitude it moved slowly eastward, and at the time of 'cut-off' it was over the Central Appenines near Bercete. Through a partial failure of the parachute, the stack sustained some damage from impact of the equipment with the ground, and about 10 per cent of the emulsion was destroyed.

After processing, the stack was divided among the Bristol, Milan and Padova groups; and among workers in the Universities of Brussels and Genoa, in the University College and the Institute for Advanced Studies, Dublin, and in the Institute for Theoretical Physics, Copenhagen. During the first four months spent on the examination of the plates, about 400 *K*- and *Y*-particles have been found, and it is now known that the total number of such particles recorded in the stack is of the order of 80,000. It appears certain that the potentialities of the method will be fully realized; it will be possible, for example, to make very accurate measurements of the masses of the heavy mesons and hyperons, and to determine the relative frequency of occurrence of particles decaying in different modes. Values of the highest precision will depend, however, on observing a sufficiently large number of stopping secondary particles to ensure that the errors due to straggling are small, and on a verification of the range–energy relation in the high-energy region.

The most important of the results obtained hitherto are summarized below. They are based on the measurements of the first observed secondary particles with a long path-length in the stack. In determining the energy of a meson from its observed range, the range–energy relation of Baroni *et al.*[1] has been employed. It has also been assumed that for a particle of energy ~100 MeV. the value of the energy for a given range may be in error by about ± 1·5 per cent.

Decay of *K*-Mesons

Most of the secondary particles observed hitherto in the *G*-stack have energies of emission corresponding to the modes of decay referred to as χ and K_μ, respectively.

(*a*) *The* χ*-mode.* The χ-meson was originally defined[2] as a heavy meson which, when it decays at rest, emits a charged π-meson with an energy of 116 ± 5 MeV., and a single neutral particle; the

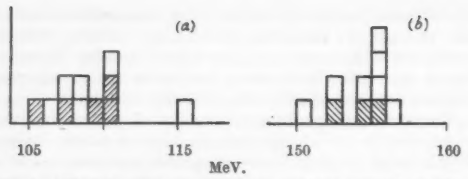

Fig. 1. Shaded areas correspond to particles arrested in the emulsion

rest-mass of the neutral particle was believed to be less than 300 m_e. The accumulation of evidence from experiments with plates and Wilson chambers has shown that the transformation proceeds according to the equation, $\chi^+ \rightarrow \pi^+ + \pi^0 + Q$, the kinetic energy of the charged π-meson being about 108 MeV.; it follows that the mass of the particles decaying in the χ-mode is, if at all, very little different from that of the τ-meson.

In a group of twelve secondary particles observed in the *G*-stack which can be attributed with confidence to the χ-mode, there are five examples in which the secondary particle stops in the stack and shows the characteristic transformation $\pi \rightarrow \mu \rightarrow e$. The ranges of these particles all fall in the interval between 11·2 and 12·0 cm., and the mean value is 11·71 ± 0·25 cm. The corresponding value of the energy is 108·4 ± 3 MeV. (see Fig. 1)—very close to that given by the early estimates—and of the mass of the parent meson, 966 ± 12 m_e. It may be emphasized that it will be possible to reduce the errors greatly by accurate measurements on the range–energy relation, and by attention to various possible sources of small systematic errors.

In seven events of a similar character, the secondary π-meson fails to reach the end of its range through interacting with a nucleus, or because it leaves the stack. In such cases, the velocity of the particle near the point where the track terminates can be determined by grain-counts or scattering observations, and then the corresponding value of the residual range. The values of the initial range of the π-meson thus determined are frequently only a little less accurate than those in which the full range is observed (see Fig. 1 *a*).

In one of the examples of the χ-mode of decay, the tracks of two electrons, which form a close pair of total energy ~ 116 MeV., are observed together with the charged π-meson. These electrons are ejected in a direction making ~ 46° with the line of motion of a particle recoiling from the charged π-meson. This event appears to be the first example of the χ-mode observed hitherto, in which the secondary π^0-meson decays in the alternative mode: $\pi^0 \rightarrow \gamma + (\beta^+ + \beta^-)$.

(*b*) *Mode of decay* $K_\mu \rightarrow \mu + \nu$. The first evidence for the existence of this mode[3] suggested that the particle decays into a μ-meson of unique energy and one neutral particle, probably a neutrino. Its mass was given as 914 ± 20 m_e. Later work with Wilson chambers has supported the original evidence for the mode of decay, $K_\mu \rightarrow \mu + \nu + Q$, and the most recently determined values of the mass are 941 ± 17 m_e [4] and 950 ± 15 m_e [5].

Twelve secondary particles have been observed in the *G*-stack which can be attributed to the decay mode K_μ (see Fig. 1 *b*). Three of them stop in the stack and their ranges are 20·17 ± 0·45 cm., 20·47 ± 0·45 cm. and 20·67 ± 0·45 cm. The corresponding value of the mean energy of emission is E_μ = 154 ± 4 MeV., and the mass, assuming the particle transforms according to equation (2), is 971 ± 15 m_e, the *Q*-value being 390·5 ± 9 MeV. In the remaining nine events also, the values of $p\beta$ as determined by scattering measurements are consistent with those given by range (see Fig. 1 *b*).

(*c*) *Other modes of decay.* Of the other established modes of decay of heavy mesons, twenty examples of the τ-mode have been found, five examples of the τ′-mode, two examples of the κ-mode in which the secondary μ-meson is observed to stop and decay, and one example of the mode K_β.

It is very important to determine the relative frequency of occurrence of the various modes of decay as observed in a wide range of experimental conditions, for any differences would furnish proof for the presence of different types of particles among the *K*-mesons.

It has not yet been possible to make a precise estimate of the relative frequency occurring in the present experiments, but it appears certain that the κ mode is infrequent compared with χ and K_μ. A similar remark applies to the mode K_β.

Hyperons

Among many hyperons observed in the stack, there is one example of particular interest in which a charged hyperon comes to rest and decays into a π^+-meson of range 8·93 ± 0·22 cm., which shows the characteristic transformation $\pi \rightarrow \mu \rightarrow e$. The parent hyperon was therefore positively charged, and the event may be attributed to the transformation, not previously identified, $\Sigma^+ \rightarrow \pi^+ + n + Q$, where *n* represents a neutron. With this interpretation, the release of energy, *Q*, is found to be 108·5 ± 3·5 MeV., and the mass of the hyperon, 2,325 ± 7 m_e. This value is equal, within the limits of error, to that deduced from observations on the alternative mode, $\Sigma^+ \rightarrow p + \pi^0$; namely, 2,327 ± 3 m_e.

Associated Production of Heavy Particles

Observations of the emission from the same nuclear disintegration of a *K*-meson and a charged hyperon have been reported previously from a number of laboratories. In such events in which the mode of decay could be established, examples have been found in which the *K*-particle transforms in the τ-mode and probably also in the κ-mode. In the *G*-stack, a similar example of associated production has been found in which the *K*-meson decays in the χ-mode. It follows that among the other properties which they have in common, the *K*-mesons decaying in these three modes may all be produced in association with charged hyperons.

In addition to examples of the 'associated' production of *K*-mesons and hyperons, an event of particular interest has been observed which appears to represent the 'pair production' of *K*-mesons. A negative *K*-meson reaches the end of its range and appears to interact with a proton, according to the equation $K^- + p \rightarrow \Sigma^+ + \pi^-$. On examining the parent 'star' from which the negative *K*-meson was emitted, it was found that another *K*-meson had also been ejected. It appears to be significant that in the first ten examples of 'stars' providing evidence of associated production, the heavy particle formed in association with a positive *K*-meson was always found to be a hyperon, whereas in the first example of a heavy particle formed in association with a K^--meson, the associated particle was a second

K-meson. This result, if confirmed by observations of greater statistical weight, would provide important support for recent theoretical speculations[6].

Unstable Nuclear Fragments

Among examples of heavy unstable fragments of the type discovered by Danysz and Pniewski[7] which are believed to contain Λ^0-particles, two examples have been found in the G-stack which appear to represent $^4H^\dagger$ and $^5He^\dagger$. In the first, the heavy fragment reaches the end of its range and decays into two charged particles which recoil from one another, the two tracks being collinear. Preliminary estimates of the binding energy of $^4H^\dagger$ give the value $1{\cdot}2 \pm 0{\cdot}8$ MeV., close to that for $^4He^\dagger$. It may be remarked that whereas the normal nuclei of both ^4H and ^5He are highly unstable, the replacement of a neutron by a Λ^0-particle produces an assembly which is stable up to the instant of decay of the hyperon.

Detailed reports of the observations are to appear in *Nuovo Cimento*.

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THE EXPOSURE OF THE PILTDOWN FORGERY*

By SIR WILFRID LE GROS CLARK, F.R.S.

THE discovery of parts of a human skull and an ape-like jaw in gravel deposits at Piltdown some forty years ago led many able authorities to the conclusion that they were the remains of a very archaic and lowly type of man, which was given the name *Eoanthropus* (or the 'dawn man'). This interpretation, in the first instance, seemed well assured by statements that some of the remains had been found by recognized authorities *in situ* (that is to say, in hitherto undisturbed gravel), that the skull was of an unusually primitive form, that the jaw (though very ape-like) contained teeth worn flat in human fashion, that the gravel deposit itself—on purely geological evidence and on the evidence of the remains of extinct mammals found therein—was of very ancient origin (at least Early Pleistocene), and that exceptionally crude flint implements were found in the same deposit.

All this evidence has now been shown to be of a fraudulent nature. How came it that the authorities concerned with the initial study of these remains were so completely misled? In my opinion, one of the primary factors was a curious error in the initial reconstruction of the skull. Smith Woodward, who was an established authority on general vertebrate palæontology (but not himself experienced as a human anatomist), mistook a small side ridge on the roof of the skull for a *median* ridge (such as is not uncommon in certain ancient skulls) and as a result his reconstruction of the skull made it appear an unusually primitive type with an unusually small brain. This was quite an excusable error for one not versed in the intimate details of human anatomy; but it undoubtedly misled Elliot Smith, an authority on the anatomy and evolution of the brain, to make a statement, from a study of a cast of the inside of the reconstructed skull, that 'Piltdown Man' possessed the most primitive and most simian human brain so far recorded. This, of course, fitted with the evidence of the ape-like jaw, with the alleged antiquity of the gravel deposits, and with all the other collateral evidence, so that each line of evidence appeared to be entirely corroborated by all the others.

It is true that the late Sir Arthur Keith afterwards demonstrated the error in the initial reconstruction of the skull, and showed that it really belonged to quite a large-brained individual; but this did not arouse suspicions as to the authenticity of the discovery as might have been the case if the first reconstruction had been correct. In any event (as already noted) the 'finds' were made by men of established reputation, so that there was not the slightest reason why the idea of fraud should ever have been entertained by any of the professional scientists who took part in the early discussions. So far as the wear of the teeth is concerned, if there *had* been any suspicion at all that it was not natural, this suspicion would certainly have been at once dispelled by the statement of the dental surgeon, Dr. A. S. Underwood, that the worn surface of the canine tooth showed an exposure of 'secondary dentine' (which is normally produced as a reaction to severe *natural* wear). Thus the evidence of each expert seemed to be in such complete harmony with that of the others that none of them was led to examine his own evidence as critically as otherwise he certainly would have done.

The demonstration by Dr. K. P. Oakley on the basis of fluorine analysis in 1950 that the Piltdown remains were not nearly so ancient as had been supposed was the real starting point for a new inquiry, for it seemed impossible to suppose that such a primitive type as 'Piltdown man' could have existed in Sussex right at the *end* of the Ice Age (particularly as it was completely out of accord with all the other fossil evidence relating to human evolution which had since accumulated). The sinister proposition then presented itself—even if the skull itself was a genuine fossil indigenous to the Piltdown gravels, could the jaw be that of a modern ape which had been deliberately faked to simulate a fossil specimen and inserted into the gravel so as to appear a truly '*in situ*' specimen?

The main objection to this hypothesis appeared to be the flat wear of the molar teeth, a type of wear which is never found in modern apes at an equivalent stage of attrition. It was at this point that Dr. Weiner demonstrated that by filing down the molar teeth in a modern ape's jaw it was quite easy to produce an appearance astonishingly like that of the Piltdown teeth. As a result of this experiment, the Piltdown teeth were re-examined in much greater detail, and it at once became evident that they showed very definite signs of artificial abrasion. Indeed, it was these anatomical observations which led to further investigations by drilling out adequate samples of the jaw material for chemical analysis (a procedure which quite naturally had not been done

* Substance of a Friday Evening Discourse at the Royal Institution on May 20.

before for fear of mutilating what was presumed to be an absolutely unique specimen). The chemical and spectrographic analyses demonstrated beyond doubt that the jaw was a modern jaw which had been deliberately stained with iron and chromate salts to match the discoloration to be expected for fossils in the Piltdown gravels.

At this stage, we did not suspect that the other finds at Piltdown might also have been fraudulent. But our discovery of the fraudulent nature of the jaw led to an intensive study of all the other Piltdown finds, with the startling result that every one of them proved to have been 'planted' in order (evidently) to provide a complex framework of complementary evidence for the supposed antiquity of the skull and jaw. The so-called 'secondary dentine' in the canine tooth was found to be a plastic material (probably Vandyke brown paint) which had served to plug an opening inadvertently made into the pulp cavity during the process of artificial abrasion, the skull bones had been artificially stained, the geological evidence for the supposed antiquity of the Piltdown gravels was shown to be faulty, the remains of extinct mammals reputed to have come from the gravels had obviously been derived from other sources, and, finally, the acidity of the gravels was found to be such that it was difficult to suppose that any bony remains deposited in them would have been preserved for any considerable length of time.

The flint implements also showed conclusive evidence of having been artificially stained to match the deposits in which they were alleged to have been discovered. The forger had certainly shown considerable skill in forging his evidence, but he also made some serious mistakes—particularly by overdoing some of the faking. A professional anatomist, for example, could have faked the teeth much more skilfully; but, even so, the modern methods of detection now developed could easily have exposed the fake. It is only fair to the original investigators of 'Piltdown man' to point out that if these modern methods had been available forty years ago, they themselves would not have been misled in the way they were. The fact is that the investigation of the Piltdown remains, altogether apart from the exposure of a remarkable forgery, has proved a most profitable investigation, for it has led to the development and perfection of a whole battery of techniques which will not only make it virtually impossible for anyone to repeat such a deception, but which will in the future be of the greatest use in estimating the antiquity of genuine fossils.

OBITUARIES

Dr. Thomas Royds

Dr. Thomas Royds died after a short illness on May 1 at Southport at the age of seventy-one. He was born at Oldham on April 11, 1884. He studied physics at the University of Manchester under Schuster and Rutherford, working especially on the constitution of the electric spark and on the spectrum of radon and the identification of α-particles as helium atoms. With an 1851 Exhibition he went to Germany, carrying out infra-red spectroscopy under Paschen in Tübingen and Rubens in Berlin. He graduated as doctor of science in Manchester in 1912.

Royds had therefore a wide knowledge and experience of spectroscopic technique when he was appointed assistant director of Kodaikanal Observatory in India in 1911. He remained there until 1939, succeeding Mr. J. Evershed as director in 1923. Here the major part of his scientific work was done. It fell into two main sections. Exact measurements were made of the wave-lengths of lines in the solar spectrum and in the electric arc under varying conditions, to study the causes of observed displacements. Perhaps his most important contribution in this subject was his measurements of the displacements of lines to the red at the extreme limb of the sun, as studied at the total eclipse which he observed at Kamishari in the island of Hokkaido on June 19, 1936. He found that differences of shift for lines of different intensity, such as had been observed without eclipse, were maintained right up to totality and could not be ascribed to scattered light from the centre of the disk. Relativity theory was not adequate to give a complete explanation of the displacements observed. His other investigations at Kodaikanal were largely concerned with dark markings given by spectroheliograms of the sun's disk, their distribution, motions and progressive changes of inclination to the solar meridians. Other studies were made on prominences, unusual bright filaments, radiation pressure and oxygen in the chromosphere.

On his retirement from Kodaikanal, Royds went to live at Southport; but in 1942 he accepted an invitation to go to Istanbul as professor of astronomy, having to travel there by sea around the Cape under war-time conditions. He learnt in a few months to lecture in Turkish and remained in Istanbul until 1947, when he finally retired. He leaves a widow, two daughters and a son. F. J. M. Stratton

Dr. G. H. Miles

George Herbert Miles, a former director of the National Institute of Industrial Psychology, died on April 4, at the age of seventy-four.

The son of a Sussex village schoolmaster who delighted in making electrical gadgets, he followed quickly and closely in his father's footsteps. He became a teacher at the age of seventeen, and at twenty entered the Westminster Training College. Here he had his introduction to psychology; and his interest in it led him, when he had secured another teaching appointment, in Hull, to study the subject (together with physics and physiology) for a London external degree. Lacking facilities for instruction in psychology and physiology, he made his own apparatus and conducted his own courses in the practical work required. His examiners, who included Sherrington and Leonard Hill, seemed satisfied.

The inventiveness and self-reliance suggested by Miles's achievements in these early years were characteristic of him throughout his life. But they were combined with some ambivalence in his attitude to science on one hand and industry on the other. That he was capable of good scientific work was clear from his D.Sc. thesis, on immediate visual memory; but at the same time he had a strong desire to be 'practical', and an inclination to be highly critical of academics. It is significant, perhaps, that in his autobiography (*Occupational Psychology*, **23**, 193, and **24**, 31) he records a remark made to him by Munsterberg, whom he visited at Harvard in his late twenties: "I am glad you came to see me. What psychology wants now is the middleman".

A middleman he became. After service in the Royal Navy during the First World War, which gave him

still further chances of displaying his talent for invention, he gave up the headmastership of a new grammar school in North Yorkshire to join Dr. C. S. Myers and Mr. H. J. Welch in forming the National Institute of Industrial Psychology. He was appointed secretary, with his sister, Miss M. A. Miles, as his assistant. His wife, who survives him, approved this typically bold step, despite the fact that his salary was to be meagre and could not be assured for more than one year. Later, when Myers became principal, Miles succeeded him as director; and in that capacity he governed the organization, in its everyday affairs, until he was informed, in 1936, of the impending appointment of a general director, whose task was to rescue the Institute from financial difficulty. He promptly resigned.

Miles kept up his early interests to the very end, and in his last years he was engrossed in the perfecting of devices for the better training of drivers and pilots. He did it all with almost boyish enthusiasm, with tremendous persistence, and with genuine diffidence and modesty. He was adventurous and without fear, and he cared not at all for time. Those who have read his lively autobiography, and who have felt exasperated by the fact that it has scarcely a date in it, will not be surprised to learn that he never carried a watch.

ALEC RODGER

NEWS and VIEWS

The Earl of Iveagh, K.G.

LORD IVEAGH, who has recently been appointed a Knight of the Garter, has been a generous and enlightened patron of science and has himself contributed not a little to our knowledge of such subjects as soil fertility and diseases of animals. As a young man he was attracted to medicine. He persuaded his father to endow the Lister Institute and encouraged the work of two brilliant young scientists, who afterwards became famous as Sir Almroth Wright and Sir Alexander Fleming, and who were then conducting experiments in the Inoculation Department of St. Mary's Hospital, Paddington. This association led to the setting-up of the Wright–Fleming Institute of Microbiology with Lord Iveagh as its chairman. In 1929 he subscribed £40,000 to enable the Institute to extend its laboratories.

In 1912, after discussions with Sir John Russell, head of Rothamsted Experimental Station, and Almroth Wright, he offered to finance an investigation on modern biochemical lines into the making, storage and use of farmyard manure. He placed his own farm in Surrey at the disposal of the investigators and assisted with the work himself. The results were highly successful and revealed the principle involved in the making of composts. A further discovery, which he made himself, was that the marsh gas given off by vegetation fermenting in stagnant water and known to country people as 'will-o'-the-wisp' could be produced artificially from straw or manure and used for heating or lighting. Lord Iveagh next turned his attention to the bacteriological content of milk from cows and was one of the pioneers in evolving modern methods of sterilizing the production process. He also played a leading part in the early experiments for eradicating tuberculosis from dairy herds and discovering treatment for mastitis and contagious abortion, in which he worked closely with Dr. John Hammond, of Cambridge. When the National Institute for Research in Dairying was looking for a home, he helped to finance the purchase of its present premises at Shinfield, and contributed money to erect new laboratories and buildings. Since 1920 he has been chairman of its governing body. A life-long believer in the benefits which science can confer on the community, Lord Iveagh has used his wealth, not only to assist original research, but also to demonstrate by his own example as a practising and successful farmer the revolutionary improvements which can be brought about by the use of scientific methods.

College of Aeronautics: Prof. G. A. Whitfield

MR. G. A. WHITFIELD, who has been appointed professor and head of the new Department of Aircraft Electrical Engineering in the College of Aeronautics, Cranfield, was educated at Bede School, Sunderland, and at the University of Sheffield, where he graduated with special honours in physics in 1937. He joined the Royal Aircraft Establishment, Farnborough, and then worked on the development of bomb sights and automatic pilots; in the following year he went to the Research Department, Exeter, where he worked until 1943 on the development of proximity fuzes for bombs. His work in this field was recognized recently by an award made by the Royal Commission on Awards to Inventors. In 1943 Mr. Whitfield went to the Marine Aircraft Experimental Establishment to take charge of the research station at Glen Fruin for investigations into the underwater behaviour of anti-submarine weapons. In 1945 he returned to the Royal Aircraft Establishment to form a group for research into the control of guided missiles. In this field he made important contributions, particularly to the design of control systems in the presence of 'noise'. He was promoted to the rank of senior principal scientific officer in 1950 as head of the Armament Control Division of the Armament Department, where he has been responsible for the development of a wide range of sighting and fuzing devices.

Victoria University College, New Zealand: Prof. Darcy Walker

DR. DARCY WALKER has been appointed to the chair of physics at Victoria University College, New Zealand, in succession to Prof. C. N. Watson-Munro (see *Nature*, **174**, 1085; 1954). Dr. Walker was born at Palmerston North, New Zealand, and educated at the Palmerston North Boys' High School and at Auckland University College. After graduation, he entered the service of the New Zealand Department of Scientific and Industrial Research and was initially engaged on meteorological work; but during the War he was employed upon defence work that took him both to the United States and to the United Kingdom. In 1945, Dr. Walker joined Prof. M. L. Oliphant at Birmingham, obtaining the degree of Ph.D. for his work on short-lived nuclear isomers, and holding in succession various research fellowships. He spent two years, 1949–51, at Cornell University and the University of California as a Commonwealth Fund Fellow, working on the nuclear

photo-effect and on meson production in the region of 300 MeV. More recently still, he has been responsible for studies of nuclear cross-sections with protons accelerated by the Birmingham synchrotron. He has taken a leading part in elucidating the mechanism by which multiply-charged ions of nitrogen, oxygen, etc., are accelerated in the cyclotron, in studying nuclear reactions produced by them, and in investigations of charge-exchange phenomena when these heavy ions pass through matter. Dr. Walker will thus take to Victoria College a wide experience of physics gained in various countries.

University College of Rhodesia and Nyasaland: Prof. A. G. Davis

The chair of agriculture at the newly established University College of Rhodesia and Nyasaland, Salisbury, Southern Rhodesia, is to be filled by Mr. A. G. Davis, reader in agronomy at Wye College, University of London. A Canadian by birth, Mr. Davis commenced his training at the Ontario Agricultural College at Guelph, where he specialized in crop husbandry, graduating in 1936. His interest in grassland developed early and took him to the Welsh Plant Breeding Station in 1936 to undertake research on pasture mixtures, for which he was awarded the M.Sc. degree of the University of Wales two years later. He was then appointed assistant agronomist at the Station and joined the team of Sir George Stapledon and Dr. William Davies in the Grassland Survey of England and Wales, 1939. Afterwards, Mr. Davis became agronomist at the Grassland Improvement Station at Stratford-on-Avon and then head of the Herbage Agronomy Department. During this period he was responsible for many agronomic trials and published a number of papers relating to the growing of grass, clover and lucerne. In 1949 Mr. Davis was appointed lecturer in agriculture (grassland husbandry) at Wye College and became in turn senior lecturer and then reader in agronomy. He has served the University of London as an examiner in agriculture and as a member of the Board of Studies in Agriculture and Horticulture. His experience in field-work, in university administration and in directing the research of postgraduate students makes him well fitted to develop a vigorous Department of Agriculture in the new University College.

Prof. S. H. Harper

Dr. Stanley H. Harper has been appointed the first occupant of the chair of chemistry in the new University College. Dr. Harper was educated at Varndean School and at the Imperial College of Science and Technology, London, where he was awarded the degrees of B.Sc., Ph.D. After holding demonstratorships at the Imperial College and at Birkbeck College, London, he proceeded to the University of Manchester as research assistant and then in 1937 joined the staff at the Rothamsted Experimental Station to work on the chemistry of naturally occurring insecticides. He gained a London D.Sc. in 1943. In 1942 he returned to university teaching, successively occupying posts of lecturer and senior lecturer at University College (as it then was), Southampton, and is at present reader in organic chemistry at King's College, London. Dr. Harper is known for his contributions to research in organic chemistry on the synthesis of Diels's hydrocarbon (with the late Prof. G. A. R. Kon), the constituents of derris and pyrethrum, the synthesis of the pyrethrins, and the stereochemistry of olefinic compounds. He has published some sixty papers, mainly in the *Journal of the Chemical Society*; he is at present chairman of the Publication Sub-Committee of the Society of Chemical Industry.

Proposed Television Tower for Belgium

It is now well established that in order to provide a large area for the satisfactory reception of television the transmitting aerial must be erected as high as possible above the surrounding terrain. Belgium, which has so far engaged in television only on an experimental basis, intends to exploit this technical requirement to the greatest practicable extent. During a recent visit to London, the Belgian Minister of Communications, M. Edouard Anseele, said that it is intended to build the highest television tower in the world at the site of the international exhibition to be opened in Brussels in 1958. The main portion of the tower, which will be built of concrete, will be in the form of a truncated cone, 450 m. high; and this will be surmounted by a cylindrical structure of ten stories with provision for technical services and a restaurant. On top of this will be mounted the television antenna structure at a maximum height of 635 m. above the ground. This is more than twice the height of the Eiffel Tower, which is about 300 m.

Status of Technical College Students

Mr. S. Rubinstein's presidential address to the Association of Teachers in Technical Institutions, delivered on May 29, welcomes the withdrawal by Sir David Eccles of Circulars 242 and 245 relating to economy in education and new building; but in regard to the latest award on special allowances, he urges that what is needed is an increase in all scales to attract in sufficient numbers the teachers of quality essential for a first-rate public educational service. He regards the range of 15–25 per cent of grammar school and technical school places as meaning a grave limitation of opportunity for children; in regard to technological education, he claims that the 4,736 full-time students doing advanced work in major technical colleges for university courses and 6,140 students in non-university classes, with 6,433 and 26,098 part-time students, represent a contribution comparable with the 29,273 full-time and 816 part-time university students in science, technology and agriculture. He also urges that there is little reason for any differentiation in grants to students between the technical colleges and the universities. Speaking of the curriculum in technical education, Mr. Rubinstein emphasized that any one-sided form of education is undesirable. Both science and the humanities are necessary to comprehend the world: the arts student should have some knowledge of science and of scientific method, and the technical student should be reasonably well informed on matters such as literature, economics and the current clash of ideas which go to make up the pattern of society.

Geological Collection for the University of Sheffield

The Department of Geology of the University of Sheffield has recently received an exceptionally valuable collection of minerals from Mr. A. W. G. Kingsbury. The basis of the collection includes specimens from three famous mineral collections—those of Thomas Kingsbury (1777–1854), Lord Shuttleworth of Burnley and Baroness Burdett-Coutts—to which have been added specimens by Mr. Kingsbury himself. It contains some five

hundred specimens of important minerals, all of which are perfect examples and many are extremely rare. Each specimen is accurately named and localized. The collection will be known as the A. W. Kingsbury Collection of Minerals; part will be on permanent display and the remainder made available for the use of students and interested persons in accordance with the wishes of the donor.

Journal of Inorganic and Nuclear Chemistry

THE first number of a new *Journal of Inorganic and Nuclear Chemistry*, published by the Pergamon Press, of London and New York, appeared in March (pp. 164). The subscription per volume (six numbers) is 90*s*. (12.60 dollars) or, for individual subscribers certifying that the journal is for their private use, 70*s*. (9.80 dollars). The editors are J. J. Katz (Chicago), H. C. Longuet-Higgins (Cambridge) and H. A. A. McKay (Harwell), and there is an international editorial advisory board. The *Journal*, which has the support of many distinguished chemists, is intended to be international in character and will publish papers of the necessary standard from any source. The first number has made a good start. It contains papers from the United States, Great Britain, France, Germany and Sweden, all of which are of a high standard.

Periodicity of Spore Discharge in an Ascomycete

C. T. Ingold and V. J. Cox (*Ann. Bot.*, N.S., **19**, 74, 201; 1955) have discussed this phenomenon in the light of experimental investigations. In *Daldinia concentrica* spore discharge under natural conditions is periodic, most spores being discharged during the night and few in the daytime. An experimental study was made of discharge under controlled conditions of light and temperature. In continuous darkness periodic discharge was maintained for twelve days; but then, although spore output continued, it ceased to be periodic. Return to alternating light (12 hr., 100 foot-candles) and darkness (12 hr.) at once re-established the periodicity. In continuous light (100 foot-candles) periodic discharge ceased after 2–3 days, but was immediately re-established in alternating light (12 hr.) and darkness (12 hr.). When the fungus was placed under conditions of alternating light and darkness each of six hours duration, two peaks of spore-output were soon developed in the 24-hr. period. The experiments suggest that the natural periodicity is determined by the alternation of day and night.

The Mithras Head of the City of London

IN the April number of the *Museums Journal*, Dr. H. J. Plenderleith, of the British Museum Laboratory, describes the treatment and restoration of the marble head of Mithras found in the City of London during excavations in the Walbrook Mithræum. The head came from a moist clayey site, was in a damp and muddy condition and bore a dark granular incrustation of iron compounds. The stone was found to be weakened by a form of sugary decomposition which might have resulted from intense heat. The marble was allowed to dry out and much of the incrustation was removed by pointed matchsticks. Sequestration of the iron was carried out by using 'Versenol' as a complexing agent. The sugary areas of the marble were treated by applications of lime water which, in time, filled the pores of the stone with carbonate of lime. Finally, two coats of soluble 10 per cent casein were applied which had a marked effect in reinforcing the surface. This meticulous work was carried out in the British Museum Laboratory, and details of the process are given in the paper quoted.

Royal Society and Nuffield Foundation Commonwealth Fellowships

AWARDS under the Royal Society and Nuffield Foundation Commonwealth bursaries scheme have been announced as follows: Prof. N. P. Badenhuizen, professor of botany, University of the Witwatersrand, to enable him to study the application of radioactive isotopes to problems of starch granule growth, at the Postgraduate Medical School, London (September–November 1955); Mr. D. H. Colless, lecturer in parasitology, University of Malaya, to enable him to study mosquito collections at the British Museum (Natural History) and elsewhere to solve certain problems in Culicine systematics (July–December 1955); Dr. M. Davies, senior lecturer in chemistry, University College of Wales, Aberystwyth, to enable him to visit Sydney (January–September 1956) to work in the field of molecular structure, infra-red spectroscopy and dielectric absorption; Dr. A. A. Kinnear, Institute for Pathology, University of Pretoria, to enable him to study endocrinological techniques at Birmingham (July–September 1955); Dr. J. H. D. Millar, consulting neurologist, Royal Victoria Hospital, Belfast, to enable him to study electrocorticography at the Montreal Neurological Institute (September–November 1955); Prof. S. R. Palit, Indian Association for the Cultivation of Science, Calcutta, to enable him to study the use of radioactive compounds and photochemical techniques in polymerization at Birmingham and other centres in Great Britain (July–August 1955); Prof. M. Sharif, professor of zoology, University of the Panjab, Lahore, to enable him to study ecological and insecticidal techniques practised at the London School of Hygiene and Tropical Medicine (July–September 1955); Prof. P. A. Sheppard, professor of meteorology, Imperial College of Science and Technology, to enable him to visit Melbourne and Sydney (September 1955–January 1956) for investigation of the interaction between atmosphere and ocean in relation to the general circulation of the atmosphere; Prof. J. B. Warren, Physics Department, University of British Columbia, to enable him to visit Canberra (August 1955–August 1956) to study the photodisintegration of nuclei. This is the third group of awards under the scheme which was instituted in 1953 to provide facilities for increasing the efficiency of scientists of proved ability by enabling them to pursue research, learn techniques or follow other forms of study in natural science in countries other than their own in the Commonwealth where the physical or personal environment, or both, are peculiarly favourable.

Leverhulme Research Awards, 1955

THE following Leverhulme Research Awards, among others, have been made for work on the subjects indicated. *Fellowships:* R. B. Benson (principal scientific officer, Department of Entomology, British Museum (Natural History)), comparison of the northern sawfly fauna of Canada with that of Europe; Dr. H. O. Foulkes (senior lecturer in pure mathematics, University College, Swansea), symmetric functions and group theory; Prof. C. F. C. Hawkes (professor of European archæology, University of Oxford), the Mediterranean relations of

trans-Alpine and Western Europe, 1400–400 B.C.; Miss P. M. Kemp (formerly lecturer, University of Allahabad), household economy and technology of some tribal communities in the Punjab; Dr. P. F. R. Venables (principal, Royal Technical College, Salford), training schemes in certain industries, with special reference to the work of technical colleges and the needs of smaller firms. *Research Grants:* Dr. R. Common (lecturer in the Department of Geography, University of Glasgow), the geomorphology of the lower Vardar and Aliakmon valleys, Greece; Dr. Florence N. David (reader in statistics, University College, London), the history of probability and statistics; L. W. Derry (head of the Department of Metallurgy, Battersea Polytechnic, London) and E. W. Wilkins (Royal Aeronautical Society), a statistical investigation into the fatigue properties of certain non-ferrous metals; P. M. Fraser (Fellow of All Souls College, Oxford), a corpus of Ptolemaic inscriptions; Dr. O. R. Gurney (Shillito reader in Assyriology, University of Oxford), the Assyrian literary tablets from Sultantepe now in Ankara; Dr. V. H. Heywood (systematic botanist), a botanical investigation of the mountainous zones of south-east Spain; P. A. D. Hollom (accountant), distribution of field characters of birds of the eastern Mediterranean region; S. H. F. Lloyd (director, British Institute of Archæology, Ankara), Beycesultan excavations—a supposed centre of late Bronze Age civilization in non-Hittite Anatolia; Dr. A. G. Lowndes (schoolmaster, Plymouth College), tracer minerals and deep-water drift in the western approaches to the English Channel; Dr. A. Lamont (geologist and journalist), faunas of cherts in the southern uplands of Scotland; Miss R. L. B. Moss (editor, *Topographical Bibliography*), ancient Egyptian inscribed and sculptured objects in Russian museums; Dr. F. J. North (keeper, Department of Geology, National Museum of Wales, Cardiff), a biography of Sir H. T. de la Beche, founder of the Geological Museum; Dr. H. Scott (formerly assistant keeper, Department of Entomology, British Museum (Natural History)), biogeographical research at high altitudes in south and south-eastern Ethiopia; Dr. Marjorie M. Sweeting (tutor in geography, St. Hugh's College, Oxford), physiographical investigations in the 'Cockpit Country' of Jamaica; A. Young (lecturer in the Department of Applied Mathematics, University of Liverpool), analysis of observations of the variation of latitude.

Commonwealth Fund Fellowships

The Committee of Award of the Commonwealth Fund Fellowships announces the following elections, among others, for 1955–56: *General Fellowships:* M. F. Atiyah, Trinity College, Cambridge (mathematics); A. O. Betts, Royal Veterinary College, London, and Cambridge (veterinary science); D. J. Candlin, Trinity College, Cambridge, and Birmingham (physics); M. A. E. Dummett, All Souls College, Oxford (philosophy); H. M. Frey, Balliol College, Oxford (chemistry); K. W. Gruenberg, Magdalene College, Cambridge, and Queen Mary College, London (mathematics); C. W. McCombie, Aberdeen (physics); A. R. Muir, Edinburgh (medicine); J. C. Polkinghorne, Trinity College, Cambridge (physics); A. P. Ryle, Trinity College, Cambridge (biochemistry); K. E. Snelson, Trinity College, Cambridge (engineering); J. H. Williamson, Edinburgh, Christ's College, Cambridge, and Queen's University, Belfast (mathematics); D. G. Wilson, Birmingham and Nottingham (chemical engineering); P. D. Wood, Aberystwyth and Reading (geography); *Home Civil Service Fellowships:* W. J. Bray (Post Office Engineering Department); F. Caunce (Ministry of Education); A. W. Peterson (Home Office); H. P. Rowe (Treasury); J. Seddon (Ministry of Supply); *Colonial Civil Service Fellowships:* M. F. H. Abraham (Kenya); J. H. Alman (North Borneo).

University of Birmingham

Prof. T. U. Matthew, Lucas professor of engineering production in the University of Birmingham, is resigning from his chair on appointment to a post with Tube Investments, Ltd. The following have been appointed lecturers in the University: H. Gilmour (petroleum production engineering) and Dr. A. Sagarra (chemical engineering). The title of University Research Fellow has been given to the following during the tenure of their present posts. *Physics:* Dr. J. C. Bower (senior lecturer in physics, University of Melbourne); Prof. G. Martelli (Pisa); Dr. K. K. Damodaran, Dr. S. J. Goldsack and Dr. M. M. Winn (Department of Scientific and Industrial Research). *Chemistry:* Dr. J. R. Urwin (lecturer in chemistry, University of Adelaide); Dr. H. Weigel (Aachen). *Experimental Pathology:* Dr. D. R. Stanworth and Dr. S. T. C. Wright.

National Research Council, Canada: Members

The following have been appointed new members of the National Research Council, Canada, for three years from April 1: Dr. R. S. Jane, executive vice-president, Shawinigan Chemicals, Ltd., Montreal; and Dr. H. G. Thode, principal of Hamilton College and director of research at McMaster University, Hamilton, Ontario. Three other members of the Council have been reappointed for a further term of three years: Dr. C. J. Mackenzie, president of the Atomic Energy Control Board, Ottawa; Dr. T. Thorvaldson, emeritus dean of graduate studies, University of Saskatchewan, Saskatoon; and Dr. W. H. Watson, professor and head of the Department of Physics, University of Toronto.

Royal Society of South Africa: Council

The Council for 1955 of the Royal Society of South Africa has been elected as follows: *President*, S. H. Haughton; *Honorary General Secretary*, W. J. Talbot; *Honorary Treasurer*, N. Sapeika; *Acting Honorary Editor of Transactions*, A. M. Talbot; *Honorary Librarian*, E. Newbery; *Other Members of Council*, H. B. S. Cooke, W. J. Copenhagen, J. H. Day, R. Elsdon-Dew, C. van Riet Lowe, S. M. Naudé, S. H. Skaife and J. L. B. Smith.

American Academy of Arts and Sciences

The following have been elected officers for the year 1955–56 of the American Academy of Arts and Sciences: *President*, J. E. Burchard; *Vice-President of Class I* (Mathematical and Physical Sciences), E. L. Bowles; *Vice-President of Class II* (Biological Sciences), H. Hoagland; *Vice-President of Class III* (Social Arts and Sciences), D. F. Edwards; *Vice-President of Class IV* (Humanities), R. Ulich; *Secretary*, W. C. Greene; *Treasurer*, T. B. Adams; *Editor and Librarian*, W. M. Whitehill. The following have been elected, among others, foreign honorary members of the Academy: Class I, Prof. A. C. B. Lovell, professor of radio astronomy in the University of Manchester; Class II, Dr. J. A. M. Runnström, of the Wenner-Grens Institute for Experimental Biology, Stockholm.

Linnean Society of London

THE following have been elected officers of the Linnean Society of London for the session 1955–56: *President*, Dr. H. Hamshaw Thomas; *Treasurer*, Colonel F. C. Stern; *Secretaries*, Dr. George Taylor (botany) and Mr. H. R. Hewer (zoology); *New Members of Council*, Mr. P. R. Bell, Dr. Margaret E. Brown, Dr. A. J. Cain, Mr. C. C. Hentschel and Dr. H. Hamshaw Thomas. The following were appointed vice-presidents for the session 1955–56: Dr. A. Tindell Hopwood, Lieut.-Colonel R. B. Seymour Sewell, Colonel F. C. Stern and Mr. E. J. H. Corner. Dr. B. O. Dodge (New York), Prof. E. Melin (Uppsala) and Prof. W. R. Taylor (Michigan) were elected foreign members of the Society, and Mr. Gerald Atkinson was elected an associate *honoris causa*.

Physical Chemistry of Enzymes: Faraday Society Discussion in Oxford

THE Faraday Society will be holding a general discussion on "The Physical Chemistry of Enzymes" in the University Laboratory of Physiology, Parks Road, Oxford, during August 10–12, under the chairmanship of the president of the Society, Prof. R. G. W. Norrish. A general introduction to the subject will be given by Dr. M. Dixon (Cambridge). The discussion will be in two parts, dealing respectively with characterization and physical properties and with kinetics and mechanisms, and twenty-nine papers will be read, advance proofs of which will be ready early in July. College accommodation is available in Oxford and must be booked by August 2. All inquiries should be directed to the Secretary of the Society at 6 Gray's Inn Square, Gray's Inn, London, W.C.1.

The Botanical Research Fund

THE Botanical Research Fund is a small private trust fund founded in July 1913. The first Trustees to be appointed were Dr. E. M. Berridge, Mr. A. D. Cotton and Miss Gulielma Lister. The purpose of the Fund is to encourage research in botany in all its branches and to assist research workers, more especially women and particularly those with some previous experience of research and who, for some reason, may not be eligible for grants from public or university funds. The method is to make short-term grants in aid of maintenance, research expenses or assistance. The grants may be renewed in special circumstances; but assistance over lengthy periods is not contemplated. Further information can be obtained from the hon. secretary, Dr. E. M. Delf, 243 Haverstock Hill, N.W.3.

Announcements

UNDER the terms of the scheme to commemorate the late Lord Rutherford of Nelson, the Council of the Royal Society has appointed Mr. N. W. Tanner, a graduate of the University of Melbourne, as a Rutherford Scholar for three years from October 1, to carry out research in nuclear physics in the Cavendish Laboratory, Cambridge.

THE following appointments have been made in the University of Sheffield: Dr. A. L. Cullen, to the chair of electrical engineering; Dr. G. B. Greenough, to be senior lecturer in physical metallurgy; and J. O. Isard, to be lecturer in the Department of Glass Technology.

THE Italian Society of Geophysics and Meteorology is offering two prizes of 100,000 lire each (about £60) for an original work on the physics of the solid earth or hydrosphere and on the physics of the atmosphere, respectively. The prizes are open to persons of any nationality, and joint contributions are permissible. The work, written in Italian, must be sent before February 29, 1956, to the Società Italiana di Geofisica e Meteorologica, via Balbi 5, Genova.

FOR the first time, the Fisheries Research Board of Canada has awarded scholarships similar to those of the National Research Council of Canada. One fellowship worth 1,400 dollars, seven studentships worth 1,100 dollars each, and four bursaries worth 800 dollars each have been awarded for the year 1955–56. The funds for these awards have been made available by the Fisheries Research Board, and the selection of candidates was made by the Board with the help of the National Research Council.

THE General Electric Co., Ltd., has decided to award annually two scholarships to employees in its home establishments or associated companies so that they can take a degree, do research or generally pursue a course of higher learning in a technical or scientific subject (including management or commerce). In general, there will be no restrictions on a candidate's age or choice of subject. Scholars will undertake to remain with the Company for three years after the completion of their course, and will spend an agreed period in one of the Company's establishments during vacations. They will continue to receive their normal emoluments, and the Company will pay for their maintenance and fees at the university or other establishment where the scholarship is held.

THE annual meeting of the Society of Chemical Industry will be held in Birmingham during July 11–16. Included in the programme will be the presentation, on July 13, of the Society's Medal to Sir Eric Rideal, followed by his address on "Colloid Science"; and on July 14 the Chance Memorial Lecture, given by Mr. H. V. Potter, of Bakelite, Ltd., who will speak on "Welfare in Industry". A historical exhibition illustrating the rise of the chemical industry in the area during the past two hundred years will be shown in the University of Birmingham throughout the meeting. Further information can be obtained from the honorary secretary of the Birmingham and Midland Section of the Society, J. H. Bennitt, c/o Bakelite, Ltd., Redfern Road, Tyseley, Birmingham 11.

A CONFERENCE on the "Use of Isotopes in Agriculture" will be held during January 12–14 at Michigan State University, East Lansing, Michigan. It will be sponsored by the council of participating institutions of the Argonne National Laboratory. There will be sessions both for invited and for contributed research papers. Details concerning the submission of papers will be published later. The guest speakers from abroad are to be Dr. S. J. Folley (Shinfield, Reading) and Dr. A. Gustafsson (Stockholm). Co-ordinated with this, the American Association for the Advancement of Science and the Oak Ridge Institute for Nuclear Studies will sponsor a related conference on "Atomic Energy and Agriculture" at Atlanta during the Georgia meetings of the American Association during December 26–30. At East Lansing the papers will deal especially with laboratory problems, experimental approaches and results. The Atlanta sessions will be concerned with the present status and future outlook for applications of atomic energy in agriculture.

AERO RESEARCH, LTD.: TWENTY-FIRST ANNIVERSARY

THE firm of Aero Research, Ltd., at Duxford, Cambridge, owes its inception in 1934 to the urge of a university man—Dr. N. A. de Bruyne, at that time a Fellow of Trinity College, Cambridge—to carry out his own applied research work. This type of firm is probably commoner abroad than in Britain, although the Cambridge Instrument Co., Ltd., may be cited as another example.

During the first few years of its life as a small research unit, it pioneered a number of developments that have since proved their worth. These include structural materials for aircraft, honeycomb structures (British Patent 577,790 of 1938), the analysis of sandwich stabilization (*J. Roy. Aero. Soc.*, **44**, 1; 1940) and the conception and realization in 1941 of the technique of metal-to-metal glueing for aircraft structures. This work on metal-to-metal adhesives called for both an investigation of the problems of adhesion (see, for example, *Aircraft Engineering*, **16**, 115, 140; 1944. *J. Sci. Instr.*, **24**, 29; 1947. *Research*, **6**, 362; 1953) as well as the production problems presented by its almost immediate application in the de Havilland Hornet fighter. The techniques developed at that time remain the basis of the widespread use of 'Redux' glue in modern civil aircraft. The report on the Comet aircraft accidents unequivocally exonerated this method of construction and, in view of the conclusions reached by the inquiry, its use is to be welcomed as a method of reducing stress concentrations (Duncan, W. J., *Engineering*, **179**, 196; 1950).

In all its projects the company has consistently emphasized the need for the research man to follow through to the final application of his work, as evidenced even in 1934 by the building of a complete aeroplane to demonstrate the value of concepts, such as Wagner's tension field analysis, that were new at that time (*R. and M.* 1694).

On the outbreak of the Second World War the company made for the Ministry of Aircraft Production thirty Miles Magister tail-planes, and a Spitfire fuselage of plastic material; their performance on test (including flight trials of a tail-plane) was entirely satisfactory, but as the shortage of light alloys was overcome, the need for substitutes disappeared. With the rise in aircraft speeds that has since taken place, however, interest in plastics for aircraft has considerably revived. A war-time development that considerably accelerated the production of wooden aircraft and gliders was the 'strip heating' process for which the Royal Commission on Awards to Inventors made an *ex gratia* award.

Until 1946 the company had been wholly owned by Dr. N. A. de Bruyne, but in that year a majority shareholding was taken up by Ciba, Ltd., the world-wide organization known for its research in dyestuffs, pharmaceuticals and plastics. Under an arrangement with Ciba, Ltd., Aero Research, Ltd., continued under its own board as an active research centre, as well as becoming a large production unit for 'Araldite' epoxy resins and the 'Aerolite' urea formaldehyde adhesives which the company had been making since 1937.

The recent visit of H.R.H. the Duke of Edinburgh on April 20 provided a fitting occasion to celebrate the twenty-first birthday of the company by a display of research and production, including some of the new high-temperature adhesives which are now under development.

FATIGUE IN METALS

AT a joint meeting in the Clarendon Laboratory, Oxford, on April 15, of the Oxford Local Section and the Metal Physics Committee of the Institute of Metals, the morning session was devoted to a discussion on "Fatigue". Prof. G. V. Raynor (Birmingham) presided, and invited papers were given by Dr. N. Thompson (Bristol) and Dr. J. Holden (National Physical Laboratory, Teddington). Dr. Thompson first mentioned the usual analysis of a fatigue experiment into three stages, consisting respectively of a period of rapid work-hardening, a long secondary stage in which local deformation may increase slowly but nothing much seems to happen, and a short third stage in which a crack is rapidly propagated, leading to failure. In contrast to this, recent work suggests that the formation and growth of the crack occupy a considerable part of the second stage, and Dr. Thompson devoted most of his introductory talk to a discussion of the evidence for what he described as this still slightly heterodox view.

In specimens containing notches, it is generally accepted that a crack may be present from an early stage in the fatigue life. The difficulty here is to explain why this crack does not spread rapidly, and no very convincing reason has yet been given. In plane specimens, without deliberately introduced stress raisers, cracks are not normally visible until just before failure. A theoretical model, due to Head, suggests that the length l of a crack is given by a formula of the type

$$l^{1/2} = 1/A(N_\infty - N)$$

where N is the number of cycles, and N_∞ the number of cycles to failure. The rate of growth of the crack is thus proportional to $l^{3/2}$, and since this varies so rapidly, it is possible that for a large part of its life the crack may be too small to be visible. The few experimental measurements which have been made are in agreement with Head's equation.

Dr. Thompson next mentioned some experiments by Sinclair and Dolan, in which fatigue tests on α-brass were interrupted every 20 per cent of the estimated life in order to give the specimen a half-hour annealing treatment at 400° C. These anneals had no effect on the fatigue life, although the specimen was completely resoftened at every stage. Sinclair and Dolan suggested that the only type of defect which would survive the annealing treatment was a small crack, which must thus have been formed in the first 20 per cent of the life. Similar experiments at Bristol in which copper specimens were annealed

at 600° C. every 10 per cent of the estimated life produced the same result.

In recent work at Bristol, specimens of high-purity copper were given a careful surface preparation and finally electropolished before testing in push–pull at 1,000 c./s. The specimens were removed and examined at various stages in the experiment. It was found that the eventual fatigue crack always originated from an intense slip band formed in the early part of the deformation; the path of the crack in both directions from this point was shown by a very high density of slip markings, while the central portion was relatively free from slip. To reduce difficulties caused by the complex nature of the surface markings, the specimens were re-electropolished at various stages during the experiments, a standard technique allowing the removal of $\sim 2\mu$ of material. This polish was found to remove nearly all the slip markings, but a few remained and are called 'persistent' slip bands. Persistent slip bands appeared after about 4 per cent of the fatigue life, and increased in number during the experiment; after about 40 per cent of the life, some of them had definitely spread into neighbouring grains, and after 70–80 per cent of the life they were recognizable as small cracks. Application of a large tensile stress to a specimen containing a number of persistent markings resulted in the opening out into visible cracks of all the markings which extended over more than one grain diameter. These markings thus represent microcracks, and the evidence strongly suggests that cracks form at a very early stage in the fatigue process. Dr. Thompson ended by pointing out there is some uncertainty in the description of a very small crack in the early stages of the process; the question of whether or not the persistent markings are microcracks when they are less than one grain diameter in length may be partially a matter of definition.

Dr. Holden's paper was concerned with the now popular view that recovery processes occur during the course of fatigue, even at room temperature. Specimens which are normally metallurgically stable thus become unstable during fatigue conditions, and diffusion and related phenomena may be greatly increased. The effect on precipitation was illustrated by recent experiments at the National Physical Laboratory on iron, copper and commercial aluminium, in which a progressive loading technique was used. The behaviour of the iron and aluminium specimens was essentially similar, and indicated that greatly enhanced ageing occurred, especially in the aluminium.

A more direct indication that diffusion is facilitated during fatigue is provided by experiments on the internal oxidation of copper alloys containing 0·01 per cent silicon. The process of internal oxidation depends on the inward diffusion of oxygen atoms through a surface sub-scale layer, and the diffusion of silicon atoms within the alloy. Under static conditions, it is known that periods of about one month are required to produce a detectable sub-scale at 300° C. Fatigue tests at this temperature resulted in oxide precipitation within the gauge length after 200–300 hr., although there was no sign of precipitation within the unstressed parts of the specimens.

Having demonstrated the existence of enhanced diffusion effects, Dr. Holden finally outlined experiments now being undertaken with the object of determining the type of lattice defect which is responsible. Low-angle X-ray diffraction studies are being made on 50-μ copper foil specimens given pulsating tension fatigue tests. After testing for less than 5 per cent of the fatigue life, very pronounced low-angle streaks are found, and these appear to be generally similar to the streaks observed in the very early stages of ageing. The streaks vary from grain to grain, and are unaffected by annealing the foil for an hour at 150° C.

In the general discussion, some attention was paid to the nature of the persistent slip markings. Dr. Thompson emphasized that they are retained after annealing, and are not simply large steps, since the standard electropolishing treatment has been found to remove the slip bands formed by static tensile deformation. Mr. M. Mallon (Shrivenham) said that persistent slip markings were formed when α-brass was deformed more than 20 per cent, but closer examination showed them to be composed of very small etch pits. Mr. G. Smith (Cambridge) described work on fatigue tests at stresses below the fatigue limit. Etch-pits were found to remain in regions where large slip bands had been visible before polishing; on testing at higher stresses, these linked up together to form markings.

In reply to a question, Dr. Thompson said that the cracks in his specimens always originated from the free surface, even though push–pull testing was used. He described further experiments in which 20–30μ of surface material was removed, and the persistent slip markings then disappeared. The markings on one specimen were removed in this way after ~ 25 per cent of the estimated life, and testing at the same stress was then resumed. This procedure was repeated seven times in all, so that the specimen had lasted for 225 per cent of its normal life, and there seemed no reason to doubt that the process could be continued until there was no specimen left.

Dr. R. T. Parker (Banbury) pointed out that Dr. Thompson's results implied that the grain size should be an important factor in fatigue; there was general agreement on this, but critical data seem to be lacking. Dr. A. N. Turner (Banbury) raised the question of fatigue in non-metallic materials, and also asked about experiments on single crystals. Dr. Thompson said that experiments on single crystals at Bristol had given essentially similar results to those on polycrystalline material; the crack again originated in an intense slip band. Dr. E. G. Stanford (Banbury) mentioned Hanstock's work on fatigue, in which internal friction measurements were used. The results did not seem to agree with Dr. Thompson's work. Dr. Thompson pointed out that these experiments involved non-uniform stresses, and were made on precipitation-hardening alloys, which are metallurgically unstable under fatigue conditions. Experiments at Bristol have shown that the internal friction is associated with the total number of visible slip bands; it is markedly affected by annealing, but not by the surface dissolution. There is thus no direct correlation between internal friction and fatigue.

In reply to a question, Dr. Holden amplified his remarks on the low-angle X-ray experiments. By analysing the distribution of X-ray intensity, it is hoped to distinguish between effects caused by arrays of dislocations and those due to excess concentrations of lattice vacancies. The session concluded with a description by Dr. H. M. Rosenberg (Oxford) of recent work on fatigue at the Clarendon Laboratory. *S–N* curves for brass and copper have been determined at room temperature, 90° K. and 20° K. At a given stress level, the fatigue lives were in the approximate

ratios 1 : 10 : 100. More significantly, the stress required for failure after a given number of cycles increased in the same ratios ($\sim 1 : 1{\cdot}5 : 2$) as the static ultimate tensile strength. Work at liquid helium temperature, now proceeding, shows still further increase in fatigue life, although the correlation with the change in ultimate tensile strength is no longer valid. No one seemed to have a ready explanation for these rather surprising results.

The afternoon session of the meeting was in the form of a general discussion, in which a panel of members of the Metal Physics Committee attempted to answer questions suggested by the local section. The current interest in fatigue problems was shown by the question, "Why have very high-strength aluminium alloys a fatigue strength no better than that of medium-strength alloys ?", which produced, in effect, a continuation of the morning discussion.

J. W. Christian

AROMATIC SUBSTITUTION

On March 29 a symposium was held by the Chemistry Department of Queen Mary College, London, on "Aromatic Substitution", with Prof. E. R. H. Jones in the chair. The six contributions covered various aspects of electrophilic, nucleophilic and homolytic substitution.

Prof. M. J. S. Dewar reviewed the general theory of aromatic substitution in terms of the Wheland transition-state treatment and the molecular orbital method. The latter method may be used to calculate the position of substitution in polycyclic alternant hydrocarbons, and the results obtained are generally in agréement with the experimental results. The theory does not take into account steric hindrance, which appears to occur particularly in α-naphthalenic positions such as the 4-position in phenanthrene. Electrophilic substitution in heterocyclic systems was then discussed and the molecular orbital theory shown to be applicable in this field. Finally, Prof. Dewar described work being carried out on the nitration of quinoline which shows that this reaction proceeds by different mechanisms in acetic anhydride and sulphuric acid solution. In the subsequent discussion Prof. E. D. Hughes emphasized the importance of the reagent and also the effect of temperature on the orientation of the substituent. Prof. Dewar agreed and illustrated the effect of the reactivity of the reagent.

Dr. G. Baddeley[1] discussed the Friedel–Crafts acylation and alkylation of aromatic compounds, and emphasized the effect of the reactivity of the reagent on the nature of the product. With aluminium chloride in methylene chloride solution the usual orientation rules were observed, whereas if the solvent was nitromethane or ether the reagent was less reactive and 'abnormal' products were obtained. This was illustrated with numerous examples such as the substitution of anthracene, which occurs in the 9-position in methylene chloride solution but in the 1- and 2-positions in nitromethane solution. Dr. Baddeley ascribed the abnormal orientation to complex formation between the catalyst and solvent, attack by the bulky complex being liable to steric hindrance. Dr. E. A. Braude suggested that reversibility of the reaction might account for the abnormal orientation in polar solvents, but Dr. Baddeley said that, if excess aluminium chloride is avoided and the hydrogen chloride removed, the reactions are not reversible.

Dr. P. B. D. de la Mare then read a paper on the chlorination and bromination of aromatic compounds. He stated that these reactions, when carried out by a solution of the halogen in hydroxylic solvents, can be shown kinetically to involve molecular halogen, but that brominations by aqueous hypobromous acid have a kinetic form which implies that the electrophilic reagent carries a full positive charge. Dr. de la Mare then compared molecular halogenation with ionic nitration and showed that the results suggest that, while the positively charged reagent evokes the inductive effect of the substituent most powerfully, the molecular reagent evokes the conjugative electromeric effect more powerfully.

The afternoon session was opened by Dr. N. B. Chapman, who gave a short survey of nucleophilic substitution and then proceeded to discuss the nucleophilic displacement of halogen. He directed attention to possible duality of mechanism (analogy with saturated systems) and to the possibility of complexity of mechanism in bimolecular processes, and outlined the structural requirements for nucleophilic substitution in homocyclic aromatic compounds. Dr. Chapman then discussed the quantum-mechanical background to the nucleophilic displacement of halogen in heterocyclic compounds (mono- and di-aza-naphthalenes) and gave an account of some kinetic investigations which have provided kinetic results for comparison with the approximate quantum-mechanical calculations; the agreement between the calculated and observed activation energies is not very good. In the discussion Dr. E. Parker suggested that the structure of the transition-state might involve *d*-orbitals, and this suggestion was generally accepted as being probable. Prof. Dewar suggested that a comparison of calculated activation energies with observed rates of reaction might be more correct and lead to a better agreement between theory and experiment.

Prof. W. Bradley discussed nucleophilic substitutions in which hydrogen is replaced by an anion, the formation of *o*-nitrophenol from nitrobenzene and potassium hydroxide being a typical example. The reactivity of the nucleus towards nucleophilic substitution decreases from anthracene to naphthalene to benzene, and nucleophilic substitution is facilitated by a carbonyl or nitro group attached to the nucleus, the positions *ortho-para* to the group being preferentially attached. Numerous examples show that, on direct hydroxylation with potassium hydroxide, mono-ketones and di-ketones yield respectively mono- and di-hydroxy compounds, and substitution by other anions follows a similar course. Prof. Bradley then gave several examples where substitution by an anion is accompanied by self-union of two molecules of the aromatic reactant, usually via a carbon atom *para* to a carbonyl group. He expressed the view that this is due to the anion functioning as a base and removing a proton from the aromatic reactant.

Prof. D. H. Hey opened his paper on homolytic substitution[2] by outlining the reactions by which phenyl radicals may be generated, and he then briefly discussed the partial rate factors for the phenylation of a series of mono-substituted benzene derivatives. He described the phenylation of toluene, ethylbenzene *iso*propylbenzene and *tert*butylbenzene; with the first three of these compounds the reactions are complicated by dimerization due to side-chain attack.

In the case of *tert*butylbenzene this does not occur, but there is a marked steric opposition to substitution at the *ortho* positions which results in the first example of overall deactivation encountered in homolytic substitution. Prof. Hey then outlined some recent investigations on the proportions of the isomeric phenylpyridines formed in the phenylation of pyridine using a number of different sources of phenyl radicals. The results were independent of the source of the radical, except when the source was phenylazotriphenylmethane. This anomalous result was shown to be due to the formation of a by-product in which it appeared that the triphenylmethyl grouping was incorporated.

In view of the interest aroused by this symposium and by one held last year[3] at Queen Mary College, it has been decided to make the symposium an annual event, dealing with some topic of current interest in the field of organic reaction mechanisms.

M. F. Ansell
M. J. S. Dewar

[1] Baddeley, G., *Quart. Rev.*, **8**, 355 (1954).
[2] Hey, D. H., *et al.*, *J. Chem. Soc.*, 3352 (1954), and earlier papers.
[3] Ansell, M. F., and Dewar, M. J. S., *Nature*, **173**, 898 (1954).

SOIL ZOOLOGY

EASTER SCHOOL AT NOTTINGHAM

THE second Easter school in agricultural science in the University of Nottingham School of Agriculture, Sutton Bonington, held during April 1–7, was devoted to soil zoology. This symposium and colloquium were limited to a membership of seventy, which included not only a large number of specialists in soil zoology and pedology, among whom were several distinguished scientific workers from other European countries, but also a number of biologists who wished to acquaint themselves with this field. The function of the meeting, therefore, was to provide a tilting-ground for discussion of papers delivered by specialists and, in addition, tuition by lecture, demonstration and practical class-work for those less familiar with the ramifications of this rapidly growing subject.

After the address of welcome by Prof. E. G. Hallsworth, the opening paper, on soil animals, by Prof. W. Kühnelt (Vienna), and the subsequent paper by Dr. P. W. Murphy (Rothamsted) on the ecology of the fauna of the forest soils, served as introductions to soil zoology and enabled the later more specialized contributions to be viewed in their ecological perspective. The difficulty of extracting animals from the soil in a condition which permits identification and in quantities which reflect the sizes of field populations has long been recognized. The paper by Mr. A. Macfadyen (Oxford), on a comparison of sampling methods for soil arthropods, was therefore welcomed by the entomologists present. An informal address on flotation methods of extraction was also given by Dr. F. S. J. Hollick (Cambridge). Dr. F. Raw's paper on a flotation extraction process for soil micro-arthropods was demonstrated in his absence by his colleagues, Mr. J. M. Dobson and Mr. J. W. Stephenson (Rothamsted). As a direct result of careful extraction methods, information on the distribution of animals in the soil is increasing. This was well shown by the studies of Mr. D. H. Murphy (Durham) on long-term changes in Collembola populations, with special reference to the fauna of moorland soils; by Mr. N. Haarløv (Copenhagen) in his contribution on vertical distribution of mites and Collembola in relation to soil structure; and by Dr. C. Overgaard Nielsen (Femmøller, Denmark) in his survey of a year's results obtained by a recent method for the extraction of soil-inhabiting enchytraeid worms. The roles and distribution of earthworms were dealt with in two papers: Dr. W. J. Guild (Edinburgh) on earthworms and soil structure, and Dr. J. E. Satchell (Nature Conservancy, Grange-over-Sands) on some aspects of earthworm ecology.

Although most of the practical difficulties in the identification of soil animals were adequately explained in the practical classes, Dr. G. O. Evans (British Museum) gave a most useful talk on the problems encountered in naming terrestrial mites. The general biology of some of the less-worked groups was covered by Dr. B. G. Peters (Rothamsted), speaking on soil-inhabiting nematodes; by Mr. J. G. Blower (Manchester), on myriapods as soil animals; and by Mr. W. V. Harris (Commonwealth Institute, London—*in absentia*), on termites and the soil, this last lecture being introduced by Mr. W. A. Sands (Commonwealth Institute). A group with which the average zoologist is even less familiar, that of the predaceous fungi, was very ably dealt with by Dr. C. L. Duddington (London) and Dr. Mary Peach (London).

The relations of soil type and agricultural practice to the fauna of agricultural land were outlined in two lectures by Prof. W. Tischler (Kiel). The penultimate session was almost entirely devoted to the more practical aspects of soil ecology. A brief review was given by Mr. E. B. Brown (National Agricultural Advisory Service, Cambridge) in his paper on some current British soil pest problems. Mr. F. G. W. Jones (Cambridge) gave particular attention to one class of pests in his paper on quantitative methods for the estimation of cyst-forming eelworms in the soil. Some of the interesting aspects of the application of insecticides to soils were discussed by Mr. J. G. Sheals (Glasgow) in the effects of DDT and BHC on soil Collembola and Acarina.

On the last morning Prof. W. L. Kubiëna (Madrid) showed a series of coloured slides illustrating the micro-structure of soil, paying special attention to the humus type. This was a fitting end to the meeting, as the cardinal importance of animal activity in the determination of humus type was demonstrated. Moreover, Prof. Kubiëna's remarks helped pedologists and zoologists alike to a more rigorous appreciation of the terms 'mull', 'mor' and 'moder', terms often used and as often misused during the meeting. On the last morning also, a number of valuable contributions which it had unfortunately been found impossible to incorporate in the formal proceedings were read 'by title', their texts having been circulated during the course and opportunity given for their discussion.

Several hours each day were devoted to practical demonstrations of various techniques, with adequate opportunities for testing them individually. All the demonstrations attracted considerable attention, and though it is perhaps invidious to single out any particular one, special interest was shown in the soil-sectioning technique developed by Mr. N. Haarløv and Dr. T. Weis-Fogh.

In general, this meeting at Sutton Bonington was a great success, and much of the credit is due to the exceptional facilities provided at the School of

Agriculture and to the preparatory work and organization done by Mr. D. K. McE. Kevan and his small staff. The entire proceedings of the Easter school, including the techniques demonstrated and the discussions of papers, will be published shortly (by Butterworth's Scientific Publications), edited by Mr. Kevan.

O. Gilbert
J. Hobart

A CONDITIONING LABORATORY FOR THE INVESTIGATION OF PERSONALITY AND CORTICAL FUNCTIONING

By Dr. C. M. FRANKS
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A SOUND-PROOF conditioning laboratory has been established at the University of London Institute of Psychiatry (at the Maudsley Hospital, London, S.E.5) in the Department of Psychology. At present the laboratory is equipped for eye-blink conditioning (the unconditioned stimulus being an air puff and the conditioned stimulus a tone), psychogalvanic reflex (P.G.R.) conditioning and cardiac conditioning. The subject is seated at a small booth with his head resting against a padded head-rest and his feet on a foot-rest, so that his field of vision is largely confined to the walls of this booth. All stimuli are rigidly standardized, being delivered and recorded electromechanically; the relative durations and times of onset of the stimuli are controlled by electronic timers. Thus the total experimental conditions are accurately standardized and capable of precise duplication by workers in other laboratories.

A novel feature of the conditioning apparatus is the method of recording the eye-blink movements. Hitherto, various mechanical or electromechanical methods have been used, both in Great Britain and elsewhere. Almost all these methods involve attaching an artificial eyelash to the eyelid or placing electrodes on or near the eyelid. Such methods are inconvenient for the subject and especially unsuitable for psychiatric patients. The present method requires no direct contact with the eye or eyelid. It is based on photoelectric principles and is to be described in detail elsewhere. A small photoelectric cell, sensitive in the visible region of the spectrum, is mounted on one lens of a pair of plain-glass spectacles. As the eyelid blinks, so the amount of light reflected on the cell cathode changes. The varying e.m.f. generated in the photo-cell is then fed into a linear amplifier and used to drive the recording pen of a recording milliammeter.

The major experiment carried out at the laboratory has been a follow-up and elaboration of an observation originally made by Pavlov. Before discussing this observation, it is first necessary to review briefly the main tenets of Pavlov's theory of cortical functioning. Pavlov's theory[1] emphasizes two basic processes, namely, 'excitation' and 'inhibition'. The excitatory process is said to be produced during the formation of a positive conditioned reflex. As evidence for a state of excitation being present in the cortex, Pavlov cites the fact that a stimulus which was not originally used as a conditioned stimulus may be able in certain instances to elicit the conditioned response. This is supposed to be because the excitatory process, originating largely in the sensory areas of the cortex which received the impulses from the conditioned stimulus source, irradiates the adjacent areas. A similar argument, based on experimental findings, is used by Pavlov to explain the formation and irradiation of the inhibitory process. It is necessary to stress here that the inhibitory process, as conceived by Pavlov, is a positive process and not merely the absence of excitation. As to the physiological nature of this process, Pavlov admits his ignorance. The term 'inhibition' is perhaps an unfortunate one, since it is used by contemporary psychologists and physiologists in at least three different senses. There is the psychiatric usage of the word, as generally applied to the withdrawn, introverted individual; there is the neurological usage of the word; and there is the present Pavlovian usage.

Pavlov experimented solely with animals. He noticed that a certain kind of dog (which he called the excitatory kind) appeared to be more excitable than other dogs; such dogs developed stable positive conditioned reflexes with ease and retained them readily. Another kind of dog (which he called the inhibitory kind) was, on the other hand, timid, cowed and cautious. These dogs developed positive conditioned responses poorly and they were easily disrupted. After further consideration and experiment with these two kinds of animals, Pavlov concluded that the excitatory type of dog which formed conditioned reflexes readily possessed a predominance of cortical excitation, and that the inhibitory type of dog which formed conditioned reflexes poorly possessed a predominance of cortical inhibition. In his later years Pavlov[2] studied—but never investigated experimentally—psychiatric patients. In particular, he made an observation concerning two kinds of neurotics, the neurasthenic and the hysteric. He concluded that the neurasthenic possessed an exaggeration of the excitatory process and the hysteric an exaggeration of the inhibitory process. Unfortunately, he never followed this observation up, and it has been largely neglected by psychologists and psychiatrists ever since.

It is possible, however, to predict that the neurasthenic patient should condition readily and that the hysteric should condition poorly. The concept of neurasthenia, as used by Pavlov, would seem to be included in the present-day concept of 'dysthymia', as developed by Eysenck[3], which comprises the anxiety states, the obsessive compulsives and the reactive depressions. As well as being neurotic, all dysthymics have in common a marked predisposition towards introversion. Similarly the hysterics—and psychopaths—as well as being neurotic have a marked tendency towards extraversion. Implicit in this classification is the mutual orthogonality of the two dimensions of neuroticism and introversion–extraversion. Using eyelid and psychogalvanic reflex conditioning, it has been experimentally demonstrated in this laboratory that, as demanded by the theory, the dysthymic patients condition readily and the hysteric and psychopathic patients condition poorly.

Spence[4] and his co-workers have demonstrated that anxious subjects are superior to non-anxious in the development of conditioned eye-blink responses. Similar results were obtained by Welch and Kubis[5], using psychogalvanic reflex conditioning. This may

be because they are more neurotic than non-anxious subjects, or it may be because they are more introverted. If the former were true, then all neurotic subjects would condition better than normal ones; if the latter were true, then dysthymic neurotics would condition readily and hysteric and psychopathic neurotics would condition poorly. Thus the present experiment is a crucial one. It would seem that conditionability is related to introversion–extraversion (which in its turn is related to cortical excitation–inhibition) and not to neuroticism. Support for this conclusion is given by the fact that introverted normal subjects condition better than extraverted normal subjects. If conditioning is related to cortical excitation, then drugs such as caffeine should increase conditionability, and drugs such as sodium amytal should decrease conditionability. The tentative conclusions from a small pilot study carried out in this laboratory upon sixteen subjects, using intravenous sodium amytal, would suggest that, as predicted, one effect of this drug is to reduce the conditionability of the subjects.

In this preliminary study of sodium amytal and conditioning, the effects of practice and of varying the size of the amytal dose were also considered. An additional variable incorporated into the experimental design was the effect of using a placebo injection. All these variables were related to changes in personality as measured by questionnaire scales such as the Maudsley Medical Questionnaire (neuroticism) and Guilford's *STDCR* scales (introversion–extraversion and neuroticism). Another interesting finding is that this drug apparently has an effect upon the retention of, or ability to form, conditioned eye-blink reflexes as manifest in the re-test situation. In a future study it is hoped to confirm and relate this finding to certain aspects of learning by rote carried out under comparable experimental conditions.

Pavlov demonstrated that certain cortical operations in his dogs resulted in an increase in inhibition and a consequent decrease in conditionability. This would suggest that certain types of brain damage in human subjects, or certain brain operations, such as prefrontal leucotomy, would also result in a decrease in ease of conditionability.

Perhaps it is of interest to mention here that Mrs. A. Petrie, of the Institute of Psychiatry, has carried out an investigation into the effect on personality of a variety of brain operations[6]. Her published results to date have shown that the personality measurements associated with the dysthymic type change consistently in the direction of extraversion after excisions in the frontal lobe but not after excisions in the cingulate and certain other areas. Included in one of her current projects—carried out in association with Mr. R. A. Willett at this Institute—is an investigation into changes in eye-blink conditionability following on these brain operations.

The programme of the conditioning laboratory includes further experiments with drugs which act as cortical excitants or depressants, and with drugs which increase or decrease sympathetic nervous activity. It is hoped to relate the changes in personality and in conditioned response behaviour caused by these drugs to simultaneous changes in the subjects' electro-encephalograms. It is also hoped to condition reflexes other than those already mentioned. If sufficient reflexes are investigated, covering both central and autonomic nervous systems (each subject would be conditioned upon each reflex separately), then it should be possible to establish the existence or otherwise of a general factor of conditionability in man.

[1] Pavlov, I. P., "Conditioned Reflexes" (trans. by G. V. Anrep) (London: Oxf. Univ. Press, 1927).

[2] Pavlov, I. P., "Lectures on Conditioned Reflexes", 1, "The Higher Nervous Activity (Behaviour) of Animals" (trans. by W. H. Gantt) (London: Laurence and Wishart, 1927); 2, "Conditioned Reflexes and Psychiatry" (trans. by W. H. Gantt) (New York: International Publishers, 1941).

[3] Eysenck, H. J., "The Scientific Study of Personality" (London: Routledge and Kegan Paul, 1952); "The Structure of Human Personality" (London: Methuen, 1953).

[4] Spence, K. W., and Taylor, J., *J. Exp. Psychol.*, **42**, 183 (1951). Spence, K. W., and Farber, I. E., *J. Exp. Psychol.*, **45**, 116 (1953).

[5] Welch, L., and Kubis, J., *J. Psychol.*, **23**, 83 (1947); *J. Nerv. Ment. Dis.*, **105**, 372 (1947).

[6] Petrie, A., "Personality and the Frontal Lobes" (London: Routledge and Kegan Paul, 1952).

THE WATER SUPPLY OF LONDON

THE easy way of providing a bacteriologically pure domestic water supply is to own or control a gathering ground in a remote and uninhabited district—say, in central Wales—to prohibit farming on it and the access of the public to it, and after storage, to treat this water by filtration and chlorination before it is distributed. The extension of farming during the Second World War and, since then, the increasing numbers of people who want to walk, cycle or motor in the less-inhabited parts of Great Britain have made it difficult to adhere to this policy in its extreme form; the Central Advisory Water Committee of the Ministry of Health recognized this in a report published a few years ago, and recommended that, though the public should not have general access to the banks of storage reservoirs, they should be allowed access to the remainder of a gathering ground*.

Even with this relaxation, however, the water undertaker with a catchment area in a remote district is still in a much more fortunate position than the water authority of London—the Metropolitan Water Board—which supplies about one-sixth of the population of Britain. Its raw water is drawn mainly from the Thames and the Lee—rivers, alkaline in reaction, flowing through lowland farming country, and polluted by sewage effluents and industrial discharges—bacteriologically unsafe, therefore, at the source, and an excellent medium for the growth of algæ. From this raw material the Board produces a treated water acknowledged to be of the highest quality. How this is done is explained in the informative and detailed reports of the Board's Director of Water Examination, of which the thirty-fifth has recently been issued†.

Partly, of course, it is done by providing first-class treatment plant and by carrying on continuous research to improve the design and operation of it. But, in addition, the Director of Water Examination has on his staff teams of bacteriologists, biologists and chemists who keep an almost continuous watch on the quality of the water, from the river to the consumer's tap. The amount of work involved in this is prodigious; during 1952, for example, more than forty-five thousand samples of water were examined bacteriologically.

* Central Advisory Water Committee: Report of Gathering Grounds Sub-Committee. (London: H.M.S.O., 1948.)

† Metropolitan Water Board: Report on the Results of the Bacteriological, Chemical and Biological Examination of the London Waters for the Years 1947–1952. (Thirty-fifth Report.) Pp. 116+2 plates. (London: Staples Press, Ltd., 1955.) 15*s.* 6*d.*

A similar effort is needed to prevent trouble from the growth of algæ which, when present in large numbers, may greatly reduce the rate at which water can be passed through sand filters, and may also give rise to very objectionable tastes. Frequent counts of algæ are therefore made—in the Lee Valley reservoirs, for example, twice weekly—and from these observations and from the results of chemical determinations (particularly of silicate) it is now usually possible to judge when to take action which will prevent a major nuisance from occurring. Intermittent chlorination, addition of copper sulphate, and the drawing off of water from a particular depth in a reservoir are some of the means used to combat algal troubles. To be effective, however, action must be taken at precisely the right time, and the report makes it clear how very close a watch has to be kept on reservoirs and rivers for this to be possible.

In judging the bacteriological safety of a water supply, many factors are taken into account, but the chief criterion is the number of *Bacterium coli* type I present in unit volume. It is natural, therefore, that much research should have been carried out in the laboratories of the Metropolitan Water Board to improve the methods of determining the numbers of this organism in a sample; the present report includes accounts of comparative tests with media containing peptone from different sources, of tests with a chemically defined medium incorporating glutamic acid, and of a rapid test using Brilliant Green bile broth. This 'rapid' test, however, still occupies two days; it is evident that the development of really rapid methods of enumerating bacteria would be of immense service in the control of a water undertaking.

This report is the last to be presented by Lieut.-Colonel E. F. W. Mackenzie, who became Director of Water Examination in 1939 and who retired recently. His term of office thus included the period of the War when the intricate system of sewers, water mains and treatment plants on which the health of London depends was under concentrated bombardment. It was then, of course, that the meticulous system of testing and control, for which London's water authority has for so long been famous, had its most severe test; in the result, throughout the War no single case of disease which could be attributed to the water supply was ever reported.

AGERATUM HOUSTONIANUM AS A TEST OBJECT FOR GROWTH-SUBSTANCES

H. P. BOTTELIER (*Annales Bogorienses*, **1**, 3, 185; 1954), using *Ageratum houstonianum* Mill as a test plant in studies of the action of growth-substances, has investigated the relation between the epinastic curvature of the petioles and the concentration of indole acetic acid, and the effect of light thereon. He has observed that the magnitude of the curvature for a given growth-substance concentration depends on the illumination during the reaction and on the age of the leaves, the first adult leaf pair giving the highest values.

The higher the concentration of the growth-substance solution used, the greater the light intensity at which light saturation takes place. Two processes can be distinguished in which the action of the growth substance leads to an epinastic curving: in one of these light is essential, so that in the dark no curving takes place and the maximum curving appears after illumination for about twenty-four hours; in the other, curving takes place in the dark and is completely inhibited by light after four hours illumination.

In young leaves (second leaf pair) only the first process occurs, while as the leaves become older the second process becomes more and more important. Accordingly, petioles of young leaves do not curve in the dark, but do so strongly in light; as the age increases, the ability to curve in the dark increases and with the sixth leaf pair is equal to that in light. The sensitivity to illumination diminishes fairly rapidly when the petioles are kept in the dark in growth-substance solutions. With short illumination at the beginning of the experiment the curvature is smaller the shorter the illumination. Both phenomena can be explained quantitatively from the rate at which the growth substance is taken up by the petioles, if it is assumed that the growth substance is dealt with directly after it has been taken up, in light according to the first process, in the dark according to the second.

In an investigation of the synergism of indole and indole-3-acetic acid in the rooting of isolated leaves of *Ageratum houstonianum*, M. H. Van Raalte (*ibid.*, 167) has observed that the rooting of petioles of *Ageratum* induced by indole-3-acetic acid was enhanced by the addition of indole. Indole did not increase the effect of naphthalene-1-acetic acid on rooting. The oxidation of indole-3-acetic acid by a crude enzyme extract from etiolated pea seedlings, as determined with the Warburg manometric method, was decreased by the addition of indole. It is suggested that the enhancing effect of indole on the rooting of *Ageratum* induced by indole-3-acetic acid is caused by its decreasing effect on the oxidation of this growth substance in the plant.

RED LECHWE AND CHINESE SIKA

ONCE more the Fauna Preservation Society directs attention to two animals which are in danger of declining to the point of extinction (*Oryx*, **3**, No. 1; March 1955). The first is the red lechwe (*Onotragus leche leche* Gray), the position of which in Northern Rhodesia is described by W. F. H. Ansell. The second is the Chinese sika, varieties of which range from the forests of tropical Formosa to the northern snows of east Siberia; concern for each variety is expressed by Richard Glover.

The lechwe is probably the most typical of Northern Rhodesian antelopes and, according to the Director of Game and Tsetse Control for this territory, numbers have declined alarmingly in recent years. Human agents are mostly responsible for this decline, Europeans blaming Africans and Africans Europeans. Legal enactments now make it difficult for Europeans to kill red lechwes on any great scale and the only large-scale killing is the native lechwe drive, or 'chila', a traditional African way of hunting. Originally, the chila did little more than take the surplus crop of game. To-day the hunting of lechwe has become a commercial proposition, and large numbers of immature animals are being slaughtered.

The African, however, has a strong sense of the traditional, and his claim to proprietary rights over the lechwe cannot be ignored. There is a sporting atmosphere about a chila, which seems to be conducted in the same spirit as a fox-hunt or a race-meeting. There is nothing in the chila, as a method of taking game, that could be objected to by any upholder of field sports, and it involves both skill and strenuous physical effort. The African is far more likely to support conservation measures aimed at preserving his sport than he would be to co-operate in preservation for its own sake—an academic consideration quite outside his apparent interest or present understanding. No solution to this problem has yet been found; but at present it is likely to lie in the direction of control rather than in any attempt at abolition.

Chinese sikas are quite unlike the small and stocky Japanese sikas which roam so many British parks. The majority of Chinese sikas stand 3½ ft. high at the shoulder and are comparable to the average Scottish red deer. They differ from the Japanese sikas, where the antlers of the stag are greyish-black to black; in Chinese sikas they are red.

Sika deer are woodland animals and this has given rise to anxiety. Throughout this century there has been wholesale destruction of forests in China; until the Communist regime few new trees were planted.

Another reason for anxiety is that Chinese physicians have long regarded a preparation of deer's antlers as a cure for impotence. High prices are paid for the antlers, and besides the stalking of stags with rifles, the Chinese make free use of set-guns, snares and pitfalls; with these methods neither hinds nor calves are spared. Already some varieties are believed to be extinct. To-day the Chinese sika appears to have joined that group of animals—the European bison, Père David's deer, Mongolian wild horse and Hawaiian goose—the survival of which depends upon their careful management in parks and zoos outside their native habitat. In Great Britain there is a fine herd of Formosan sikas which are kept apart in a special paddock at Woburn, as well as smaller herds at Whipsnade and Chessington Zoos.

FISHERIES RESEARCH IN HONG KONG

DESPITE many difficulties and setbacks, organized fisheries research in Hong Kong forges ahead with outstanding vigour and success. Under Dr. G. A. C. Herklots, it got off to an excellent start just before the Second World War but was brought to an abrupt halt by the Japanese occupation. The early post-war period witnessed resolute attempts to revive the project, and these efforts met with some success: but it was not until the formation of a Fisheries Research Unit affiliated with the Department of Zoology, University of Hong Kong, that the project became again soundly established. In 1950 Dr. David Barker was appointed professor of zoology in the University and acting director of the new Unit. Since then, solid and rapid progress has been made. A specially designed research vessel, the *Alister Hardy*, built in a local shipyard, went into service in January 1954, to initiate an ambitious programme of researches in nearby waters (see *Nature*, **172**, 1170; 1953).

Preliminary results of much interest and value are already available and have been published in a new journal, the *Hong Kong University Fisheries Journal**. This publication carries on, under its new name, the former *Journal of the Hong Kong Fisheries Research Station*, originally launched by Dr. Herklots in 1940 but which ran to only three issues because of the War. It is intended to publish the new *Journal* annually for the time being; but as the activities of the Unit expand and multiply, publication will no doubt become more frequent. This first number is well printed on good paper and has an attractive format that does credit to all concerned with its production. It contains four papers on various aspects of fisheries biology, one on the sea snakes (Hydrophiidae) occurring near Hong Kong, and one by Prof. Barker giving an interesting and informative history of the development of fisheries research in Hong Kong.

The Fisheries Research Unit now has its own director, Mr. J. A. Tubb, a graduate of the University of Melbourne, and formerly director of fisheries in North Borneo, and it is to be expected that this, the most easterly of a chain of Commonwealth research stations in the Indo-Pacific region, will quickly become a powerful and progressive influence both locally and internationally within the region. It certainly merits the fullest measure of encouragement and support that can be extended to it by all interested in fisheries and general marine biology in those Far-Eastern waters. G. A. STEVEN

* *Hong Kong University Fisheries Journal*, No. 1 (December 1954). Edited by Prof. David Barker. Pp. iv+65+12 plates. (Hong Kong: University Press, 1954.) n.p.

ANAPHYLATOXIN, HISTAMINE DEPLETION AND SKIN REACTIONS IN THE RAT*

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AS shown before[1], incubation of rat's plasma with polysaccharides (starch, agar, inulin, etc.) generates a most potent histamine-releasing substance (anaphylatoxin), when assayed by perfusion through the guinea pig lung or by addition to a chamber containing a piece of guinea pig ileum (strong contraction followed by desensitization). Experiments performed in order to test the possibility of activating anaphylatoxin *in vivo*, by injecting starch or agar intravenously into rats, led to the result that, instead of being activated, the plasma of these rats became much less active when assayed *in vitro* with the proper amount of agar as activator. Significant drops of the content of anaphylatoxin to 5–30 per cent of the normal levels could be observed in most animals receiving the polysaccharides intravenously.

This 'depletion' of anaphylatoxin appeared to constitute a favourable condition in which to test the possible role taken by anaphylatoxin in the mechanism of production of several skin reactions involving increased capillary permeability, as revealed by the passage of a colloidal dye (Geygy blue or

* Results presented at the annual meeting of the Braz. Soc. for the Advanc. of Science, held in Ribeirão Preto, São Paulo, Brazil, during November 8–13, 1954.

Table 1

Groups	Treatments Doses (mgm./100 gm.)	No. of animals	Anaphylatoxin (plasma)	Histamine, dorsal skin (μgm./gm.)	Skin reactions (trypan blue tests)			
					Local anaphylaxis	48/80 (25 μgm.)	Dextran (20 μgm.)	Ovomucoid (20 μgm.)
Normals	None	6	100%	25·2 ± 6·1	+++	+++	+++	+++
1	Starch (150 mgm.)	6	0 to 5%	28·8 ± 1·7	± ; 0	++ ; +	+++	++ ; +
	Agar (150 mgm.)	6	0 ; 5% ; 30%		0	+++	+++	
	Glycogen (150 mgm.)	2	25% ; 50%					
2	Dextran (100 mgm. i.v.)	4	100%	4·9 ± 3·5	+++	±	0	0
	Ovomucoid (100 mgm. i.v.)	4	100%			+	0	0
	48/80 (400 μgm. i.p.)	4	100%	5·4 ± 3·5	+++	0	0	0
	48/80 (1·2 mgm. i.p.)	4	100%	less than 3·0 μgm./gm.	+++	0	0	0
	48/80 (2·0 mgm. i.p.)	2		,,	+++	0	0	0

Note. For the local anaphylactic reaction, 20 μgm. of antibody nitrogen was injected intracutaneously and 2 hr. later 2 mgm. of antigen nitrogen (egg white) plus the dye were injected intravenously.

trypan blue) from the circulation to the treated skin areas. Three potent histamine releasers, low-molecular weight dextran[2], 48/80 (condensation product of *p*-methoxyphenetylmethylamine with formaldehyde)[3] and ovomucoid[4], which are known to 'deplete' the histamine from the skin when given repeatedly to rats, were also assayed in order to see if there is any cross-desensitization towards themselves or towards the local anaphylactic reaction performed upon the rat's skin according to Ovary's technique[5], consisting in preparing the skin with a few micrograms of antibody nitrogen and two hours later injecting the antigen plus Geygy blue intravenously.

Two groups of rats were treated as follows: (1) with polysaccharides (starch, agar or glycogen) given twice at a 2-hr. interval; after the second injection, the skin test was performed; and (2) with a low-molecular weight dextran (intravenously) or 48/80 (intraperitoneally) or ovomucoid (intravenously), in repeated injections during 36 hr., in order to reduce substantially the skin histamine. The skin tests were carried out when the skin histamine was at its lowest level[1].

The capillary permeability test was carried out by injecting intravenously 0·5 ml. of a 0·5 per cent solution of Geygy blue or 1·0 ml. of a 1 per cent solution of trypan blue, immediately followed by the intracutaneous injections of 0·1 ml. in each place, of the solutions of polysaccharide, dextran, etc. After 10–15 min., the animal was exsanguinated, and the intensity of the reaction was observed in the derma of the inverted skin.

The results are condensed in Table 1. In the animals of the first group, anaphylatoxin was considerably decreased, the skin histamine was practically unchanged and blue tests with 48/80, dextran or ovomucoid were as strong as in normal animals. However, in all animals of this group, the local anaphylactic reaction (Ovary's test) was slight or completely abolished. In the animals of the second group, anaphylatoxin was at a normal level, skin histamine went down to 'depletion' levels, and yet the local anaphylactic reaction was as strong as in the control animals, although the skin reactions to the 'depleters' (dextran, 48/80 and ovomucoid) were completely abolished or very slight.

It thus appears quite clear that the mechanism by which the capillary permeability is increased by such agents as histamine releasers (48/80, dextran and ovomucoid) on one hand, and by the local anaphylactic reaction on the other, are different. It is difficult to understand why in a histamine-depleted skin the antigen–antibody reaction is not at all decreased, since there are indications that anti-histaminics, such as 'Neo-antergan', strongly depress the local anaphylactic reaction[1]. Either we have to postulate different mechanisms for the release of histamine by the components of group 2 substances and by the anaphylactic reaction, or some other substance is released in rat's skin under the action of the antigen–antibody reaction.

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USE OF SOLUBILIZING AGENTS IN GAS-PHASE PARTITION CHROMATOGRAPHY

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THE increasing number of publications relating to gas-phase partition chromatography illustrates the remarkable utility of this technique, and the descriptions of the separation of complex mixtures indicate the power and simplicity of the method. Increased column efficiency is generally obtained by increased column length and diminished particle size of the support material. These expedients, however, lead to a reduction of the rate of flow, resulting in a corresponding increase in the time required for analysis and greater diffuseness of the eluted bands. In order to overcome this, higher pressures and higher operating temperatures can be employed, but the latter may well lead to a reduction in column efficiency.

It is therefore desirable to operate the column at as low a temperature as possible and also at relatively low pressures, while maintaining column efficiency and rapidity of elution.

In an attempt to improve column operation in this direction, we have considered the possibility of modifying the stationary solvent in such a way as to lead to greater differentiation in the retention volumes of the eluted materials, and in this connexion, the great increase in solvent power resulting from the addition of, for example, the soaps or fatty acids, to a solvent led us to carry out experiments with columns of this type.

Table 1

	CH_3Cl	CH_2Cl_2	$CHCl_3$	CCl_4
Vapour pressure (mm. mercury)	3,610	348·9	159·6	91·0
Solubility (gm./100 gm. water)	0·61	2·00	0·82	0·077
Retention volume in ml. nitrogen:				
Col. 1	17	56	71	103
Col. 2	12	30	34	38
Col. 3	15	57	134	194
Col. 4	35	266	793	1,670
Col. 5	45	315	951	1,960
Col. 6	71	406	1,220	2,550

In their original publications, James and Martin[1,2] describe the improvement effected in the separation of fatty acids by the addition of stearic acid to the stationary solvent. The 'tailing' of the peaks is reduced very markedly, and the retention volumes are increased. These authors attribute the improvement to a decrease in the extent of self-dimerization of the eluted acids in the stationary phase. In the present work, we have used systems in which such an explanation is not possible, and we present here some preliminary results.

All the columns used were, so far as possible, identical in length and packing density, the solvents being supported on 120-mesh kieselguhr packed in tubing of 6 mm. internal diameter. In order to obtain definite evidence of solubilization, it was decided to use a system in which any separation due to vapour pressure differences would tend to be diminished by differences of solubility. A suitable system is that comprising the chloromethanes with water as the solvent. The vapour pressures, solubilities in water and retention volumes on the various columns used, all at 20° C., are listed in Table 1.

From the vapour pressure data, it appeared that some separation could be expected on a 'dry' kieselguhr column, and it was also possible that adsorption might play some part. The elution of a mixture on such a column (column 1) is shown in Fig. 1*a*, while Fig. 1*b* shows the elution of the same mixture on a column (2) of water on kieselguhr (20/80 by weight). It can be seen that the 'dry' column is the more effective, the retention volumes being smaller on the water column, and increasingly so with decreasing vapour pressure. Since carbon tetrachloride is almost completely insoluble in water, it is evident that there is some degree of adsorption on the dry column. These results indicate the inefficiency of water as a solvent for these materials. The use of a 60/40 by weight 'Teepol'/water mixture (column 3) as solvent results in a large increase in the retention volumes, and elution occurs in the order of increasing chlorine content of the molecule, as can be seen in Fig 1*c*.

Since the columns were of equal length and packing density and the use of water alone cuts down adsorption, it appears that the great improvement obtained by use of the mixed solvent is due to enhanced solubility.

This point of view may be used to interpret some results we obtain in non-aqueous media. In Table 1 are listed the retention volumes of the chloromethanes at 20° C. on the various columns used. Column 4 consisted of liquid paraffin on kieselguhr, while in column 6 the liquid paraffin contained 17·5 per cent by weight of stearic acid. It was found that the inclusion of the stearic acid in the stationary solvent made it impossible to obtain the same packing density, and consequently, the material in column 4 was extracted and repacked in narrower tubing (column 5) to the same length as column 6. Columns 1–6 contained the same weight of kieselguhr, while columns 4 and 6 contained the same weight of both kieselguhr and liquid paraffin.

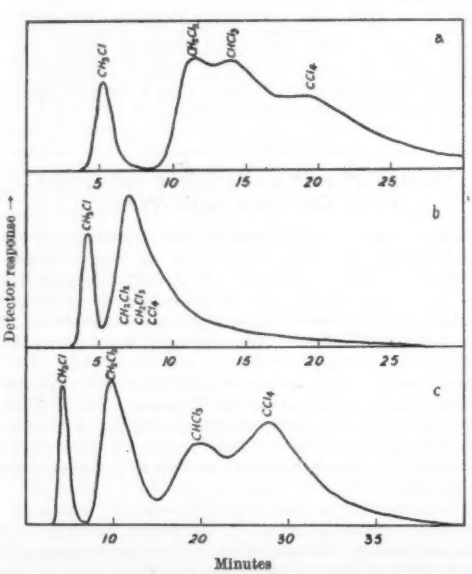

Fig. 1. Elution by nitrogen at 20° C. of chloromethanes on 38-cm. columns: (*a*) kieselguhr (6·3 ml./min.); (*b*) water/kieselguhr (6·3 ml./min.); (*c*) water/'Teepol'/kieselguhr (7·7 ml./min.)

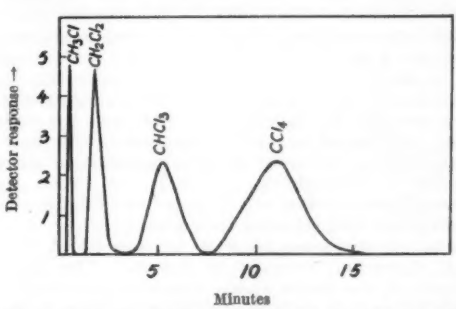

Fig. 2. Separation of chloromethanes at 20° C. on 12-cm. column of liquid paraffin/stearic acid/kieselguhr; flow-rate, 76 ml./min. of nitrogen

It can be seen from Table 1 that the retention volumes are increased by addition of stearic acid, and it is found that the peaks obtained are considerably sharper. This leads to a much cleaner separation; the increased efficiency is illustrated in Fig. 2, which depicts the separation of the chloromethanes on a column only 12 cm. long in the short time of 15 min.

This, and related work, will be discussed at greater length elsewhere. We thank Prof. R. G. W. Norrish and Dr. P. G. Ashmore for their encouragement, and one of us (M. S. S.) thanks the Department of Scientific and Industrial Research for a maintenance grant. [March 21

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LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Relation of Leuco-anthocyanins to Anthocyanin Synthesis

Among the herbaceous plants which Bate-Smith and Lerner[1] have recently found to contain leuco-anthocyanins were *Impatiens noli-tangere* and *I. parviflora* of the Balsaminaceae. We have been investigating the genetic control of anthocyanin pigmentation in *Impatiens balsamina*, which has been reported previously to produce glycosides of pelargonidin, peonidin and malvidin[2]. In the course of these studies we have obtained evidence that the leuco-anthocyanins may serve as precursors for the anthocyanin pigments. In view of current interest in the leuco-anthocyanins, this aspect of the work is presented here.

In all analyses, fresh or frozen plant parts were first extracted by boiling with 0·1 *N* hydrochloric acid, filtered, then boiled for 3–5 min. after the addition of an equal volume of concentrated hydrochloric acid. This procedure hydrolyses any anthocyanins present and converts leuco-anthocyanins to anthocyanidins. The acid extracts were washed with ethyl ether to remove flavones and certain other substances. After removal of residual ether by boiling, the pigments were transferred by partition to a small volume of amyl alcohol, from which they were spotted or streaked directly on Whatman No. 1 paper for chromatography. Ascending chromatograms were used throughout, and solvents employed were *t*-butanol/acetic acid/water (15 : 2 : 5) and *m*-cresol/acetic acid/water (25 : 1 : 24)[3]. The phenolic phase of the latter mixture served as the mobile solvent, while the aqueous phase was included within the jars in an open dish. Pigments were identified by comparison with extracts of flowers of known pigment content, by Robinson's[4] tests, and by comparison of R_F values with those reported by Bate-Smith. The sequence of spots corresponds to those reported by Bate-Smith, although the actual R_F values differ somewhat as a consequence of differences in technique and solvents employed.

Leuco-anthocyanins occur in balsams which have green stems and pure white flowers. The leuco-pigment of the stems yields cyanidin, whereas the petals and sepals contain in addition a leuco-anthocyanin which yields delphinidin.

Plants having the proper genotype produce violet-purple flowers and contain in both sepals and petals glycosides of malvidin. Buds (sepals and petals together) collected from these plants before any pigment is visible yield cyanidin and delphinidin from leuco-anthocyanins. Both leuco-anthocyanins disappear before the purple flowers mature.

Another combination of genes controls the production of bright red flowers. In this instance, petals contain only pelargonidin glycosides, whereas sepals contain both these pigments and some peonidin glycoside. Young colourless buds of this form contain leuco-anthocyanins which yield not only cyanidin and delphinidin but also pelargonidin. The leuco-pigments which correspond to cyanidin and delphinidin disappear before the flowers mature. While it is probable that the leuco-anthocyanin yielding pelargonidin also disappears during development of the flowers, this leuco-pigment cannot be detected in the presence of pelargonidin by present techniques. The appearance in young, unpigmented buds of a leuco-anthocyanin convertible to pelargonidin is invariably associated with the presence of a specific dominant gene which also governs the production of pelargonidin glycosides in mature flowers.

Pelargonidin, however, is also produced under the influence of still another gene when in the proper genetic background. Since this gene does not govern the production of the corresponding leuco-anthocyanin in early stages of the bud, we conclude that the final stages of pelargonidin synthesis may follow alternative routes.

These results provide two separate indications that leuco-anthocyanins serve here as precursors for the ultimate anthocyanins. (1) Those leuco-anthocyanins which do not correspond directly with the ultimate pigment disappear as anthocyanins develop. Leuco-anthocyanins do not disappear during the maturation of white flowers, hence the disappearance of leuco-anthocyanins and appearance of anthocyanins are controlled by the same genes. Simmonds[5] has reported a somewhat similar situation in developing bracts of the inflorescence of bananas, where non-methylated leuco-anthocyanins disappear as methylated anthocyanins appear. (2) Under the influence of a gene which has the principal effect of producing pelargonidin derivatives in mature flowers, a corresponding leuco-anthocyanin appears in colourless buds.

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Nature of a Hemicellulose extracted from Cellulose with Water

During the course of investigations leading to the development in this laboratory of the phenol–sulphuric acid procedure for the quantitative determination of sugars[1], small amounts of water-soluble carbohydrate impurities were detected in the paper (Whatman No. 1) used for separating mixtures of sugars.

We have now isolated enough of this water-soluble carbohydrate material from Whatman No. 1 filter paper to permit a more detailed examination of it. Smaller amounts of a similar material have been extracted from cotton linters and from purified wood α-cellulose.

The material, which is polysaccharide in nature, may be extracted at room temperature either by chromatographic irrigation or by simple extraction in water. When chromatographic irrigation is used, the water-soluble polysaccharide appears in the very first portion of the eluate. After re-drying in air, the same piece of filter paper will provide more

material when irrigated with water a second time; this process can be repeated many times. During the application of six alternate extraction and drying treatments to a larger sample of cellulose, it was found that the amount of material extracted remained constant after the second or third extraction (see Table 1). The material was isolated by concentration of the aqueous extract and precipitation with ethanol. The crude material showed $[\alpha]_D^{20} - 30°$ (approx.) in water and after purification via its acetate ($[\alpha]_D^{21} - 42°$ in formamide; OAc, 36·0 per cent) it had $[\alpha]_D^{20} - 53°$ in water. Hydrolysis of the polysaccharide with *N* sulphuric acid yielded a syrupy hydrolysate ($[\alpha]_D^{20} + 43°$ in water) which was shown to contain xylose (53·6 per cent), arabinose (15·8 per cent), glucose (11·1 per cent), galactose (1·9 per cent) and two acidic components which from their R_F values appeared to be a uronic acid (13·6 per cent) and an aldobiuronic acid (4·1 per cent). In some samples there have been indications of the presence of rhamnose. The quantitative chromatograms were developed with butanol/acetic acid/water[2] and pyridine/ethyl acetate/water[3], and the sugars determined by the phenol–sulphuric acid method[1]. The amount of the acidic components was determined approximately by reference to a standard glucose curve pending their complete identification. By prolonged extraction of cellulose with water, Adams and Bishop[4] have also obtained a polysaccharide composed of arabinose (16·2 per cent), xylose (35·0 per cent), glucose (41·5 per cent) and galactose (7·55 per cent).

Table 1. Extraction of Hemicellulose from Cellulose (1,000 gm. Whatman No. 1 Filter Paper) with Water at 25° C.

Extraction No.	Weight of extract (gm.)
1	0·28
2	0·16
3	0·15
4	0·09
5	0·09
6	0·09

The polysaccharide extracted from cellulose with water is now being subjected to methylation studies. The present evidence indicates that it is a pentosan containing uronic acid units as well as neutral sugars, and it appears to be similar to those found in many types of wood. Strachan[5] observed a similar phenomenon with highly purified celluloses, but attributed it to a slight solubility of cellulose in water.

While this water-soluble polysaccharide extractable from Whatman No. 1 filter paper is of interest because of its interference in microquantitative paper chromatography and in the separation of substances by sheet paper and cellulose column chromatography, it is believed that some of the peculiar and as yet unexplained properties of cellulose and its derivatives (for example, its acetate and its xanthate) may be due to this or similar water-soluble polysaccharides that are with difficulty released from the cellulose by a process of autohydrolysis induced possibly by the acidity of uronic acid units. The phenomenon also appears to be related to the deterioration of cellulose caused by alternate wetting and drying[6] and by the action of ozone at high moisture-levels[7].

The part played by hemicelluloses that are known to be difficult to remove from cellulose still remains to be ascertained. The Whatman No. 1 filter papers used in this work also contained non-carbohydrate material which could be extracted with methanol. This material, which is probably a beater additive, may cause difficulty when paper chromatography is employed for the separation of sugars. Further details of this work will appear elsewhere.

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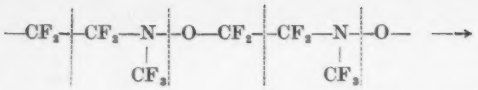
A New Type of Copolymer

Trifluoronitrosomethane, a deep blue monomeric gas[1,2], combines quantitatively with tetrafluoroethylene in the dark at − 45° to give perfluoro-2-methyl-1 : 2-oxazetidine, $CF_2.N.O.CF_2.CF_2$ (30 per cent), and an involatile colourless viscous oil (65 per cent). The oil is insoluble in the common organic solvents, and is unaffected by hot concentrated sulphuric acid or hot concentrated aqueous potassium hydroxide; its infra-red spectrum fails to show the presence of groups such as N : O, NO_2, $N : \overset{+}{N}(O^-)$, ONO, ONO_2, C : C, N : N or C : N. The oil has the same empirical formula as perfluoro-2-methyl-1 : 2-oxazetidine, C_3NOF_7, showing a 1 : 1 ratio of trifluoronitrosomethane to tetrafluoroethylene. The oil is in fact a 1 : 1 copolymer of the reactants, formed by an ionic mechanism favoured by low temperatures:

$$CF_2.\overset{\delta+}{N} : \overset{\delta-}{O} + CF_2 : CF_2 \rightarrow \overset{+}{N}.O.CF_2.CF_2^- \xrightarrow{CF_2NO} \underset{CF_3}{\overset{+}{N}.O.CF_2.CF_2.N.O^-} \xrightarrow[\text{etc.}]{CF_2NO,\ C_2F_4} \underset{CF_3}{\overset{+}{N}.O[CF_2.CF_2.N.O]_n.CF_2.CF_2^-}$$

The formation of perfluoro-2-methyl-1 : 2-oxazetidine from the intermediate $CF_2.\overset{+}{N}.O.CF_2.CF_2^-$ is also readily visualized by this mechanism. Chain termination in the polymer might involve disproportionation to give $NF(CF_3)$ and $CF : CF_2$ end-groups.

The polymer is readily soluble in perfluoromethyl-*cyclo*hexane, and the mean molecular weight is much greater than 7,000. Support for the constitution of the polymer is given by the fact that when heated *in vacuo* at 400° in absence of air, the polymer yields equimolar amounts of perfluoro(methylenemethylamine) and carbonyl fluoride quantitatively:



$$CF_3N:CF_2 + COF_2$$

This appears to be the first example of an N : O group acting like C : C in copolymerization, although it has been shown[2] that free radical addition to N : O can occur.

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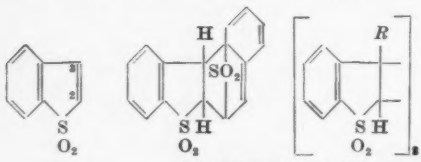
Dimerization Reactions in Sunlight

The investigations previously reported[1] have been continued and I wish to put the following facts on record. The photo-experiments mentioned below have been carried out in a sealed 'Pyrex' glass tube (Schlenk tube[2]) in an atmosphere of dry carbon dioxide; in all cases the dark experiments were negative.

It seems possible that the 2–3 bond in benzothiophene/1-dioxide[1] would undergo an analogous photo-dimerization reaction, under comparable conditions, typical of the similarly situated bond in indone derivatives, for example, 2-methyl-3-phenylindone[3]. This is indeed the case. When a benzene solution of (I) is exposed to sunlight for three days (July), it forms the difficultly soluble colourless photo-dimer, melting point 296°, from acetic acid (78 per cent yield) (found: C, 57·6; H, 3·6; S, 19·1. $C_{16}H_{12}O_4S_2$ requires C, 57·8; H, 3·6; S, 19·2 per cent). The photo-dimer, believed to be (III*a*), sublimes readily at 300° under reduced pressure; a fact which excludes the possibility that it could be regarded as a Diels–Alder dimerization adduct (II)[4].



(I) (II) (III*a*, R=H; III*b*, R=CH_3)

Similarly, 3-methylbenzothiophene 1-dioxide undergoes a photo-dimerization reaction when its benzene solution is exposed to sunlight for five days (January) to give the difficultly soluble colourless photo-dimer (III*b*), melting point 312° (82 per cent yield).

A detailed report of this work will be published elsewhere.

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Inactivation of Phage due to Assimilated Phosphorus-32 and the Recovery of Host Cells

From experiments carried out by other authors[1], who have exposed to ultra-violet light and to X-rays bacteria infected with different types of phages (*T*2, *T*7), it has been possible to obtain a general picture of the changes which take place during the latent period, from infection to the lysis of the host cells. It was found, in agreement also with other types of experiments, that phage *T*2 begins to multiply only about 7–9 min. after infection. During this period the particle is not infectious and is responsible for the changes in the host cell which lead to the synthesis of new virus. Study of this early period might thus furnish important information about the relationships established between virus and host cell.

To this end we decided to study the inactivation of the phage *BM* (active on *B. megatherium*) strongly labelled with phosphorus-32, after its penetration into unlabelled cells suspended in a non-radioactive medium. A suitable freezing technique enabled us to stop the cellular metabolism at known times after infection. Our aims were to find: (*a*) possible variations in the rate of inactivation of radioactive phage before and after its penetration into the cell; (*b*) possible variations in the rate of inactivation as a function of the time elapsed from the adsorption to the lysis of the host (about twenty minutes); (*c*) a possible recovery of the cell following inactivation of the phage after its penetration. For details of the technique of freezing and of preparation of the radioactive phage, we refer to previous publications[2,3].

Repeated controls have shown that the frozen cells of *B. megatherium* survive completely this treatment. In order to measure the rate of inactivation of the radioactive phage within the cell, we chose a low infection ratio (0·2 phage per cell), so as practically to eliminate multiple events. The infection mixture was prepared so as to ensure an adsorption of 50 per cent of the phage in 1 min.; after this time, the mixture was diluted in antiphage horse serum so as to stop adsorption and inactivate the unadsorbed phage, the concentration and strength of the serum being such as to cause inactivation of 99 per cent of the free phage in 1 min. The mixture was then diluted in broth and aerated in a suitable vessel from which samples could be taken quickly every 30 sec. and immediately frozen. In this way we obtained cells infected almost simultaneously in which the development of the radioactive phage was arrested at known times; afterwards the frozen samples were tested periodically for inactivation of radioactive intracellular phage up to 40 days.

In order to study cell recovery following the penetration and inactivation of the radioactive phage, we used infection ratios of either 1 or 3; the samples were frozen 2 or 4 min. after infection, and tested on subsequent days by colony counts to ascertain the number of recovered cells.

The inactivation curves of the radioactive intracellular phage are quite similar for the first 5 min. after infection. This result was obtained consistently in four experiments, during which this interval was examined thoroughly every 30 or 60 sec. The average value of the inactivation-rate of the radioactive intracellular phage is $k = 6·0$ (Fig. 1), a value significantly different from, and some 40 per cent less than, the inactivation-rate of the free frozen phage ($k' = 9·3$ (see ref. 3)). We have examined the behaviour of the inactivation-rate after the fifth

minute up to the lysis of the cells, and this work will be reported elsewhere.

Fig. 2 is a graph of the number of recovered cells as a function of the dose $D = 1 - (\exp -\lambda t)$, where λ is the decay constant of phosphorus-32. On the hypothesis that the distribution of phages in the bacteria is Poissonian, with the mean value $\overline{I}$, and that the inactivated phage does not interfere with cell multiplication, one obtains the expression:

$$N(D) = \sum_0^\infty I\,(1 - \exp -kD)^I \frac{\overline{I}^I\,(\exp -\overline{I})}{I\,!} \left\{ (a + \frac{2^I A}{\exp \overline{I}} \right\}$$

$$= a \exp -\overline{I}(\exp -kD) + A \exp -2\overline{I}(\exp -kD)$$

where k is the inactivation-rate of the radioactive phage during the 5 min. following infection and a and A represent the fractions of single cells and diplobacilli calculated with a phase-contrast microscope. The experimental points for the 2- and 4-min. samples are in good agreement, and the difference noticed does not seem significant. On the other hand, the points seem consistently lower than theoretical expectation (with $\overline{I} = 1$, $k = 6{\cdot}2$, $a = 0{\cdot}76$, $A = 0{\cdot}24$), even when account is taken of the errors in the parameters which appear in the formula ($\Delta\overline{I} = 0{\cdot}06$, $\Delta k = 0{\cdot}02$, $\Delta A/a = 0{\cdot}02$). This difference can be explained either by assuming that some cells are damaged by the radioactive phage even after its inactivation (in disagreement with our hypothesis), or by assuming that cells infected by too large a number of particles are not capable of recovering (this effect, phage reactivation by multiple infection, has already been noticed by other authors for phages inactivated by ultra-violet light). An examination of the number of lytic centres as a function of D enables us to exclude the first assumption. On the other hand, taking the summations in the formula only for $0 \leqslant I \leqslant 4$ we obtain good agreement with the experimental results. This is confirmed by the much larger difference observed between experimental and theoretical values in the case of an infection ratio of 3–4 particles per cell.

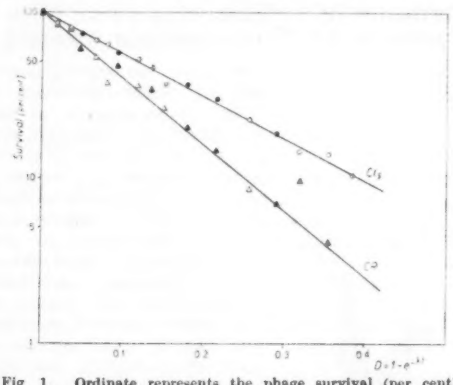

Fig. 1. Ordinate represents the phage survival (per cent); abscissa represents the dose D. *Cl*, labelled intracellular phage up to 5 min. after infection. *CR*, frozen labelled free phage

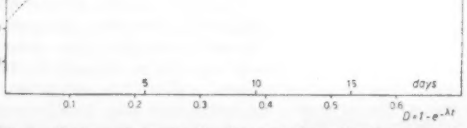

Fig. 2. Abscissa represents the dose and the ordinate represents the number N of colonies. The open and filled circles represent samples frozen 2 min. and 4 min. respectively after infection. The dotted lines represent the error on the theoretical curve (full-line curve) obtained from the errors on the parameters

These experimental results enable us to draw the following conclusions: (*a*) the fact that up to 5 min. after infection k does not vary indicates that there is no exchange between the phosphorus of the phage deoxyribonucleic acid and that of the host cell (that is, the phage deoxyribonucleic acid is not metabolized, at least during this period), and suggests that the genetic structure of the phage has a considerable independence in the host; (*b*) the difference found in the inactivation-rate before and after penetration of the phage into the cell can be explained either by supposing that a part of the phage phosphorus is lost during the infection, or that intracellular phage becomes less sensitive.

Our results suggest that in this phage system infection does not mean the suppression of the reproductive ability of the cell; moreover, the fact that almost all the infected cells are able to recover following the penetration and inactivation of the phage (at least during the first 4 min.) seems to us of importance in estimating the damage produced during the first stages of virus infection.

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Occurrence of Acid Phosphatase in Association with the Haustoria of Powdery Mildew on Barley

The intracellular haustoria of rust (*P. graminis tritici* Erikss. and Henn.) and mildew (*E. graminis hordei* Marchal) are usually regarded as absorbing organs, which, in the case of rust at least[1], only invaginate the protoplasts of the host cells. The use of radioactive tracers has shown that phosphate[2,3], sugars and products of carbon dioxide fixation[3] accumulate in infections of these obligate parasites, and the suggestion has been made that the pathogens require phosphorylated intermediates of host metabolism[4].

As part of a cytochemical investigation of haustorial development, we have examined the distribution of acid phosphatase in mildewed barley epidermis. The

observations were carried out with mildew rather than with rust, because the former is an ectoparasite and its characteristic digitate haustoria are normally confined to the non-chlorophyllous epidermal cells which are low in phosphatase activity. Moreover, suitable material for cytochemical examination can be readily obtained in the form of epidermal strips, so that paraffin embedding and sectioning are not necessary. Three techniques for acid phosphatase were employed, namely, (1) Yin's modification of the Menten–Junge–Green method[5], (2) Gomori's revised method[6], (3) Burton's azo-dye method in which rapid coupling, indicated by the formation of a black dye, is believed to eliminate diffusion artefacts[7]. In all cases fixation was carried out for 2 hr. in 80 per cent ethanol.

The Menten–Junge–Green method was abandoned after preliminary trials, which did, however, show that phosphatase was concentrated in association with the haustoria. In general, the Gomori method strikingly confirmed this preliminary result. Figs. 1 (ungerminated conidium), 2 and 3 (haustoria) illustrate the results obtained by the Gomori method. Occasional negative results with individual haustoria (Fig. 3) are assumed to be due to the vagaries of the technique[8]. The Burton method (Fig. 4) gave similar and more consistent, if somewhat less striking, results. The substrate, monosodium alpha-naphthyl acid phosphate, was prepared by the method of Friedman and Seligman[9]. Our results with plant material differ in one important respect from those reported by Burton for animal tissue, in that nuclei gave a positive reaction for acid phosphatase, as may be seen from Fig. 5. With all three techniques, incubation after inactivation by steaming or in the absence of substrate gave negative results.

It is concluded that relatively high concentrations of acid phosphatase occur within or on the haustoria of mildew, and that the agreement between the Burton and Gomori methods shows that the latter is satisfactory for use with our material. It is thought that these fungal enzymes may play an important part in the transfer of metabolites between host and parasite.

The critical application of cytochemical methods, especially those for demonstrating enzymes, might constitute a fruitful approach to many problems in physiological plant pathology and the study of disease resistance.

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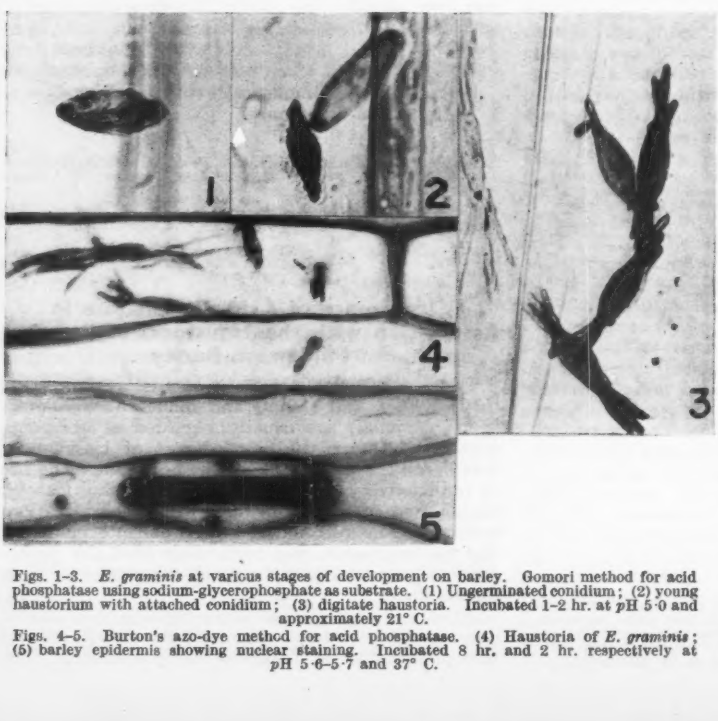
Formation of 5-Hydroxytryptophan from Tryptophan by *Chromobacterium violaceum*

Previous reports from this laboratory have established tryptophan as the dietary precursor of 5-hydroxytryptamine[1]. The demonstration of the widespread occurrence of a specific decarboxylase for 5-hydroxytryptophan[2] suggested that this hitherto unknown amino-acid was the intermediate, and that tryptophan was hydroxylated to 5-hydroxytryptophan in a manner analogous to the hydroxylation of phenylalanine to tyrosine. Although experiments with carbon-14 tryptophan resulted in slight labelling of added carrier 5-hydroxytryptophan, the conversion in mammalian and invertebrate tissues was too small for definite identification. The recent identification of violacein, the pigment of *Chromobacterium violaceum*, as a 5-hydroxyindole derivative[3] led us to investigate the metabolism of tryptophan by this organism.

The bacteria were grown in glucose–yeast extract medium for 24 hr. The cells were harvested, washed twice, and incubated with tryptophan. Table 1 shows the amounts of 5-hydroxytryptophan formed in the course of such incubation. For the purpose of identifying the product derived from L-tryptophan, 300 ml. of the incubation mixture was lyophilized after centrifugation. The dried



Figs. 1–3. *E. graminis* at various stages of development on barley. Gomori method for acid phosphatase using sodium-glycerophosphate as substrate. (1) Ungerminated conidium; (2) young haustorium with attached conidium; (3) digitate haustoria. Incubated 1–2 hr. at *p*H 5·0 and approximately 21° C.

Figs. 4–5. Burton's azo-dye method for acid phosphatase. (4) Haustoria of *E. graminis*; (5) barley epidermis showing nuclear staining. Incubated 8 hr. and 2 hr. respectively at *p*H 5·6–5·7 and 37° C.

Table 1

	6 hr.	12 hr.	24 hr.	36 hr.
30 mgm. of L-tryptophan*	0·0	0·0	0·0	0·0
30 mgm. of D-tryptophan	0·06	0·11	0·25	0·33
10 mgm. of L-tryptophan	0·17	0·38	0·68	0·46
30 mgm. of L-tryptophan	0·22	0·50	0·93	1·16

0·45 gm. (wet weight) of *Chromobacterium violaceum* was shaken with tryptophan in 0·1 *M* phosphate buffer *p*H 6·0 at room temperature in a final volume of 15 ml. Figures are expressed in terms of mgm. of 5-hydroxytryptophan formed in 15 ml. These values are minimal, since 5-hydroxytryptophan is destroyed during incubation.
* Bacteria were placed in boiling water bath for 3 min. prior to incubation.

Table 2

	Synthetic 5-hydroxy-tryptophan	Isolated 5-hydroxy-tryptophan
Paper chromatography	R_F	R_F
n-Propanol/1 *N* ammonia (5 : 1)	0·12	0·12
n-Butanol/1 *N* hydrochloric acid	0·23	0·23
Phenol/water	0·44	0·43
Spray reagent	Colour	Colour
p-Dimethylaminobenzaldehyde	Blue → Green	Blue → Green
Ultra-violet fluorescence	Pink	Pink
Ninhydrin	Blue	Blue
Nitroso-naphthol	Purple	Purple
Naphthoquinone – sulphonate	Tan	Tan

Table 3

	Amount of substrate incubated (μM)	5-Hydroxy-tryptamine formed (μM)	Con-versions* (per cent)
5-Hydroxy-D-L-tryptophan (synthetic)	1·20	0·64	53
	0·80	0·40	50
Isolated 5-hydroxytryptophan	0·54	0·45	85
	0·33	0·30	91

* Corrected for small amount of 5-hydroxytryptamine destroyed during incubation.

residue was extracted with 0·01 *N* hydrochloric acid in 90 per cent methanol and chromatographed as a streak in butanol/acetic acid/water (5 : 1 : 4). The apparent 5-hydroxytryptophan was located by its pink fluorescence under ultra-violet light after spraying with dilute hydrochloric acid, cut out, eluted and rechromatographed in *n*-propanol/1 *N* ammonia (5 : 1). The 5-hydroxytryptophan was again cut out, eluted, and assayed colorimetrically[4].

The behaviour of the isolated material on paper chromatograms and with certain colorimetric reagents was indistinguishable from that of authentic 5-hydroxytryptophan (Table 2). Incubation of the isolated material with crude 5-hydroxytryptophan decarboxylase yielded approximately the theoretical amounts of 5-hydroxytryptamine (Table 3). 5-Hydroxy-D-L-tryptophan yielded only 50 per cent of the theoretical amount of 5-hydroxytryptamine, indicating the optical specificity of the enzyme and suggesting that the isolated material was 5-hydroxy-L-tryptophan. Paper chromatography of the enzymatically formed 5-hydroxytryptamine produced single spots with R_F 0·62 in *n*-propanol/1 *N* ammonia (5 : 1) and R_F 0·23 in *n*-butanol/1 *N* hydrochloric acid. Authentic 5-hydroxytryptamine gave the same R_F values. The product formed after incubating with D-tryptophan has not yet been identified.

On the basis of this evidence, it would appear that the metabolite of L-tryptophan produced by *Chromobacterium violaceum* is 5-hydroxy-L-tryptophan. Conclusive proof of the L-configuration and further information concerning its physical properties must await isolation of larger quantities of the amino-acid.

We are grateful to Dr. Ralph De Moss for making available to us cultures of *Chromobacterium violaceum* (*A.T.C.C.* No. 553).

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Effect of Deoxycorticosterone on the Reticulo-Endothelial System

THE reticulo-endothelial system is known to be an important defence mechanism against malignant growths in general[1]. Nicol, Helmy and Abou-Zikry[2] showed that œstrogens, especially in combination with orchidectomy, stimulate the reticulo-endothelial macrophages in the liver, spleen and lymph nodes and appear to lead to mobilization of the macrophages in these organs. It is probable that such stimulation increases the general defence of the body against tumour growth.

In contrast, Nicol and Snell[3] showed that cortisone, a gluco-corticoid, depresses the activity of the reticulo-endothelial system, especially in the spleen, and suggested that this was the probable explanation for patients treated with cortisone being more susceptible to infection, and the probable reason for cortisone enhancing the spread of transplanted tumours in animals. This may also explain the prolonged remissions which sometimes occur in patients with lymphosarcoma or Hodgkin's disease[4] being treated with cortisone, for both diseases are characterized by pathological proliferation of the reticulo-endothelial system.

In view of the increasing use of hormones in the treatment of carcinoma and the apparent ineffectiveness of deoxycorticosterone, a mineral corticoid, in the treatment of Hodgkin's disease[5], it seemed desirable to study the effect of this hormone on the reticulo-endothelial system.

Twenty-five male guinea pigs, aged about one year, were used in the present investigation. The reticulo-endothelial macrophages were studied by giving all the animals one daily injection of trypan blue subcutaneously for the last six days prior to being killed by chloroform. The dosage of the dye was calculated on the basis of 0·8 ml. of a 1 per cent solution in distilled water per 100 gm. body-weight. Seven of the animals were given dye only and were used as controls. The remaining animals were divided into three groups of six and given deoxycorticosterone acetate (Organon) in addition to the dye. Six animals received 2 mgm. of deoxycorticosterone intramuscularly once daily for one week; six received 2 mgm. daily for two weeks; and six received 5 mgm. daily for two weeks. Specimens were taken from the spleen, liver and lymph nodes and fixed in Heidenhain's 'Susa' fluid. Sections were cut at 10μ thick and stained with weak eosin, dilute carbol

fuchsin or alum carmine. The activity of the reticulo-endothelial system in the organs studied was assessed by the number of dye-bearing cells and the intensity of the vital staining.

In the group of animals which received 2 mgm. of deoxycorticosterone daily for one week, four showed vital staining appearances similar to those of the controls; the remaining two animals showed reduced activity of the macrophages, especially in the spleen and to a lesser extent in the liver and lymph nodes. In the group which received 2 mgm. of hormone daily for two weeks, five of the animals showed vital staining appearances similar to the controls, and the remaining one animal showed a slight reduction in phagocytic activity; similar results were found in the group which received 5 mgm. of the hormone daily for two weeks.

These preliminary observations show that deoxycorticosterone has little or no effect on the activity of the reticulo-endothelial macrophages and in this respect greatly differs from cortisone. This difference in action between the mineral corticoid and the glucocorticoid is of great interest, and for this reason the effect of adrenocorticotrophic hormone on the reticulo-endothelial system is now being investigated.

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Binocular Vision and Deep-Sea Fish

The human binocular threshold is more than 10 per cent lower than the monocular one. This finding has been explained on a statistical basis by Pirenne[1], who assumed that the two eyes are independent. The extent to which binocular vision lowers the threshold depends on the relation between stimulus and response and on the absolute value of the threshold. The lower the threshold, the greater is the benefit.

An examination of a number of deep-sea fish[2-5] suggests that these animals have binocular vision in order to achieve greater sensitivity. They have eyes which are large and tubular and which often protrude from the head like periscopes. The visual axes are generally parallel. In some cases, the fundi are lined with tapeta. Thus there are several indications that maximum visual sensitivity is the target; the reduction in the threshold afforded by binocularity is in harmony with this design.

But an animal with eyes in front has a smaller visual field than an animal with one eye on each side of the head. Is binocularity in deep-sea fish, therefore, worth the price paid for it in terms of increased vulnerability? The answer may lie in a consideration of the light-intensity range in which they live. A 10 per cent improvement in the threshold would be of small consequence to man, whose environment ranges in intensity over many log units. But a similar small improvement might be highly appreciated in regions in which light is always at a premium. Thus at intensity-levels well above the monocular threshold, monocular views of two widely differing fields may be advantageous as compared with fused binocular views of similar fields because of the increased information afforded by the former system. But, intermediate to the monocular and binocular thresholds, there is a finite intensity-range where fused binocular vision is clearly an advantage: at such intensity-levels, it is better to be able to see a relatively small field than not to see a large one. Assuming that the eyes are independent, binocular vision may double the response near the monocular minimum[6]. Other physical devices, such as a colourless crystalline lens[7], or the presence of a tapetum[8], increase an animal's sensitivity only by a fraction of a log unit. Binocularity in deep-sea fish may rank with such second-order factors, and none the less be of critical survival value.

There is some zoological evidence supporting this view. The explanation usually advanced for the position of an animal's eyes—namely, that the hunter has eyes in front, but the hunted at the sides—does not apply to deep-sea fish[4]. The generalization fails also with other fish, for example, sharks. At least three types of deep-sea fish with tubular eyes do not seem to be predators although their visual axes are parallel. They are *Opisthoproctus*, *Winteria* and *Dolychopteryx*. They have small toothless mouths. Their trunks are trapezoidal and thus unlikely to be capable of the swift movement characteristic of streamlined bodies. They have no photophores with which to attract prey. The correlation between feeding habits and the direction of the visual axes thus does not appear to be as rigid in the sea as it is on land, since there are predator fish with non-parallel axes, and also non-predators with parallel ones.

Maximum light sensitivity may therefore be added to predacity and manipulation[4] as factors associated with binocular vision.

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Euphausiopsin, a New Photosensitive Pigment from the Eyes of Euphausiid Crustaceans

The eyes of euphausiid shrimps contain large quantities of vitamin A[1]. Fisher *et al.*[1] found a particularly high concentration of the vitamin in the eyes of *Euphausia pacifica*. These observations have led to speculation that vitamin A may play a part in euphausiid vision.

Live specimens of *E. pacifica* were dark-adapted in running sea water, and their eyes were removed in dim red light. The whole eyes were macerated with

ground glass and extracted in darkness with 2 per cent aqueous digitonin (*p*H 7·2). The extracts were cleared by filtration through sintered glass.

Fig. 1 (solid line) shows a typical absorption spectrum of an aqueous extract of dark-adapted *E. pacifica* eyes. After the initial measurements were made, the solution was left in the dark at 24° C. for 20 min. The absorption spectrum was then measured again (Fig. 1, closed circles). The two spectra were indistinguishable, and it was concluded that the extract was thermally stable (subsequent experiments proved fresh extracts to be stable in darkness at 20° C. for 8–10 hr.).

The solution was then exposed to sunlight for 20 min., after which time the absorption spectrum was redetermined; and a difference spectrum was obtained by subtracting the value of optical density for the bleached solution from that for the unbleached at each wave-length.

Absorption of visible wave-lengths by aqueous solutions from dark-adapted *E. pacifica* eyes is maximal at 463–468 mμ. The position of this maximum depends upon the ratio between the concentration of a photostable pigment, probably astaxanthin, and the concentration of a hitherto undescribed light-sensitive pigment. Identification

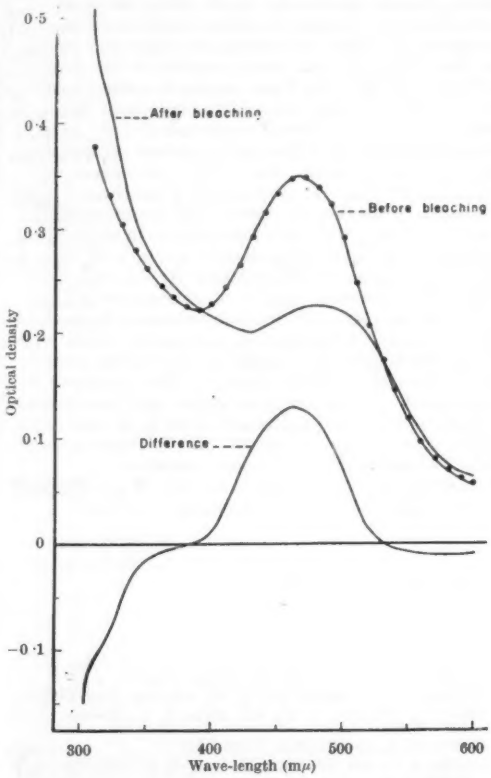

Fig. 1. Upper: Absorption spectrum of an extract of dark-adapted *Euphausia pacifica* eyes and of the same solution after 20 min. in darkness at 24° C. coincide (experimental points after 20 min. in darkness are marked ●). Absorption spectrum of the same solution after a 20-min. exposure to sunlight (marked, ——— after bleaching).

Lower: Difference spectrum obtained by subtracting optical densities after exposure to light from those before exposure to light at each wave-length

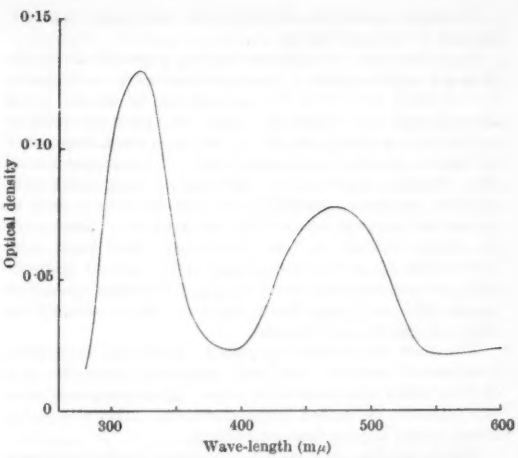

Fig. 2. Absorption spectrum of vitamin A_1 (325 mμ band) and astaxanthin (470 mμ band) in petroleum ether. This solution was obtained by extracting an aqueous extract of dark-adapted *E. pacifica* eyes with organic solvents (see text)

of the photostable contaminant as astaxanthin is supported by evidence obtained from mixed chromatograms and by the broad-band absorption in the blue-green ($\lambda_{max.}$ 470 mμ) by solutions of the contaminant in petroleum ether.

The greatest decrease in absorption caused by exposure to light occurs at 462 ± 1 mμ. Bleaching by light produces an increase in absorption in the ultra-violet. The slight hump at about 320 mμ on the direct absorption spectrum after bleaching and on the negative portion of the difference spectrum (Fig. 1) could be attributed to the release of vitamin A_1 during exposure to light.

The pigment is bleached by light of much lower intensity than that afforded by open sunlight. Difference spectra essentially identical with that shown in Fig. 1 have been obtained by placing samples of fresh extract in the light-path of the spectrophotometer for 3–4 hr. In these experiments the monochromator was set at 460 mμ, the slit width at 2 mm., and the temperature was controlled at 20° C.

Heating a sample of fresh extract to 70° C. for 20 min. in dim red light caused precipitation and a marked decrease in spectral absorption in the visible range (maximal at 468 mμ) with an increase in absorption in the ultra-violet. After exposure to heat, the solution was no longer sensitive to light.

Samples of a fresh extract were treated with equal volumes of absolute methanol, acetone and chloroform, in darkness. Each trial resulted in coagulation and loss of light-sensitivity.

These observations indicate that the euphausiid photosensitive pigment contains a protein.

Destruction of the pigment by treatment with organic reagents results in a characteristic change in the absorption spectrum. Acetone was added to a sample of the aqueous extract, and the mixture was shaken with ethyl ether. After separation, the ether fraction was dried, and the residue was taken up in petroleum ether. This solution yielded an absorption spectrum (Fig. 2) with a broad band at 470 mμ, typical of astaxanthin, and a high, narrow peak at 325 mμ, characteristic of vitamin A_1. The presence of the vitamin in bleached samples of the aqueous extract was established by the Carr–Price reaction.

Retinene (vitamin A-aldehyde) was not detected in any of the extracts.

In summary, the photosensitive pigment from the eyes of euphausiids is water-dispersable and stable in the dark at 20° C. for periods up to 10 hr. It is decomposed in darkness, and its photosensitivity is lost by heating to 70° C. or by treatment with methanol, acetone or chloroform. Decomposition of the pigment, whether by light or by treatment with organic reagents, results in a loss of colour and an increased absorption in the ultra-violet. Inasmuch as every extract so far examined has been contaminated by astaxanthin, the new pigment is probably better characterized by its difference spectrum ($\lambda_{max.}$ 462 ± 1 mμ) than by any direct absorption data at present available.

The new photolabile pigment, described here from *Euphausia pacifica*, has been extracted from the eyes of two other euphausiid species. It is proposed that the pigment be called 'euphausiopsin', after the genus from which it was first extracted.

These studies are being continued under contract between the Office of Naval Research and the Scripps Institution. I am particularly grateful to the American Philosophical Society for providing, through a grant from the Penrose Fund, the Beckman Model *DU* spectrophotometer used in the work.

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Depression in Brain Potassium in Ovine Pregnancy Toxæmia

A lowering of brain potassium has been demonstrated in insulin-induced hypoglycæmic encephalopathy in cats[1]. As ovine pregnancy toxæmia has been tentatively identified as hypoglycæmic encephalopathy[2], determinations were made of the potassium content of slices, approximately 2 mm. thick, taken from the surface of the cerebral cortex of sheep dead, or *in extremis*, from either pregnancy toxæmia or prolonged insulin hypoglycæmia. Similar samples were taken from normal sheep.

The mean potassium content of brain slices from pregnancy toxæmia cases was significantly lower ($P < 0.001$) than that of the normal brains, and that of the brains of the insulinized sheep significantly lower ($P < 0.001$) than that of either of the other two groups. The association of a lower brain potassium in both pregnancy toxæmia and prolonged insulin hypoglycæmia is consistent with our tentative identification of ovine pregnancy toxæmia as a hypoglycæmic encephalopathy[2]; but in view of the evidence that *in vitro*, anoxia and low glutamate concentration can depress brain potassium and cooling can depress retina potassium[3], it seems likely that any depression of cerebral metabolism may be accompanied by a lowered brain potassium. The decrease in brain potassium therefore does not provide unequivocal confirmation of the hypothesis; but as no other likely cause of cerebral depression has been found[2], hypoglycæmia remains as the most probable cause. The more marked depression of brain potassium in insulinized sheep reflects the more marked hypoglycæmia seen in these sheep compared with developing pregnancy toxæmia cases (unpublished work).

Table 1. Potassium Content of Brain Slices

	No. of brains	No. of samples	Mean brain slice potassium* (m.mol./kgm. dry matter)
Normal	21	164	433 ± 3·3
Pregnancy toxæmia	16	120	388 ± 4·6
Insulin	5	40	314 ± 7·3

* Determined on a flame photometer after nitric-perchloric digestion of dried slices.

Assuming a 70 : 30 distribution of water between intracellular and extracellular fluids[4] and a concentration of about 5 m.mol./l. of potassium in the extracellular fluid of sheep[5], the extracellular potassium would contribute about 1·5 m.mol./l. of wet brain or about 7 m.mol./kgm. of dry brain to the total brain potassium. Obviously, then, a depression of about 45 m.mol/kgm. in the potassium in the brain in pregnancy toxæmia and 119 m.mol./kgm. in insulin hypoglycæmia must be due largely to a depression in the intracellular potassium.

The loss in intracellular potassium is interpreted as being due to an insufficient supply of glucose to the cells, as has been shown to occur *in vitro*[3,6]. As lowered potassium concentration has been shown to limit glucose uptake by brain slices *in vitro*[7], the lowered brain potassium, once established, may be a reason for either spontaneous or induced reversal of the hypoglycæmia being ineffective as a means of relieving the symptoms unless it occurs early in the course of symptoms. The failure of sheep to show symptoms during short-term but extreme hypoglycæmias[8] and the development of symptoms during less extreme but more prolonged hypoglycæmias[2,9] may be explainable if prolonged hypoglycæmia is needed to depress the brain potassium. In view of the vital role of potassium in nerve transmission[10], the level of potassium in the cells may be the direct cause of the cerebral dysfunction rather than the insufficient supply of glucose *per se*.

Where samples of whole brain were used for analysis, no significant differences in potassium levels could be demonstrated, in contrast to the results obtained with cerebral cortical slices. This supports the indication from clinical observation and fundamental considerations, as discussed[2], that only the higher nerve centres are involved in the hypoglycæmic encephalopathy of pregnancy toxæmia.

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Brucella abortus Strain 19 cultivated in Aerated Liquid Medium

AERATED liquid culture methods[1] have been evolved to produce *Brucella* vaccine for cattle at greatly reduced cost. The shake-flask technique was employed. Rectangular flasks of four-litre capacity, containing 450 ml. liquid culture, were agitated on a shaking machine at 64 excursions per min. of 12 cm. each. The medium[2] consisted of 3 per cent peptone, 3 per cent glucose, 1 per cent 'Marmite' (yeast extract), 0·16 per cent disodium hydrogen phosphate (mol. wt. 141·98), 0·03 per cent 'Antifoam' (polyoxethylene derivative of ricinoleic acid supplied by I.C.I., Ltd.) in tap-water; *p*H 6·4.

The medium was cleared through 'Speedex' filter powder over blotting paper and sintered glass (porosity No. 2), and sterilized by filtering through a 'Ford Sterimat' (Seitz *EK*) asbestos pad. The seed, a 48-hr. potato agar culture, suspended in buffered saline (0·021 *M* Na_2HPO_4; 0·045 *M* $NaH_2PO_4.2H_2O$; 0·017 *M* NaCl; *p*H 6·4) was introduced by siphoning through a hooded pipette over a flame to produce a viable count of 500,000,000 organisms per ml. (see Fig. 1).

The growth was harvested after shaking for 66 hr. at 37·5° C. in the dark with the flasks fixed crosswise at a slant of 1 : 50 upwards to the neck to allow for a semicircular reversing agitation. A bent hooded pipette was used to siphon the culture, containing at least 150 × 10^9 organisms per ml., into buffered saline diluent to make a vaccine suspension of about 30 × 10^9 organisms per ml. This was stored at 4° C. in 10-litre flasks while samples from each flask were being tested for *p*H, purity on culture, density, viable count, *S*- to *R*-variation and tetrazolium reduction. Bulked samples of each group of batches were tested biologically for safety and immunizing quality. After bottling, purity tests were repeated in a separate laboratory.

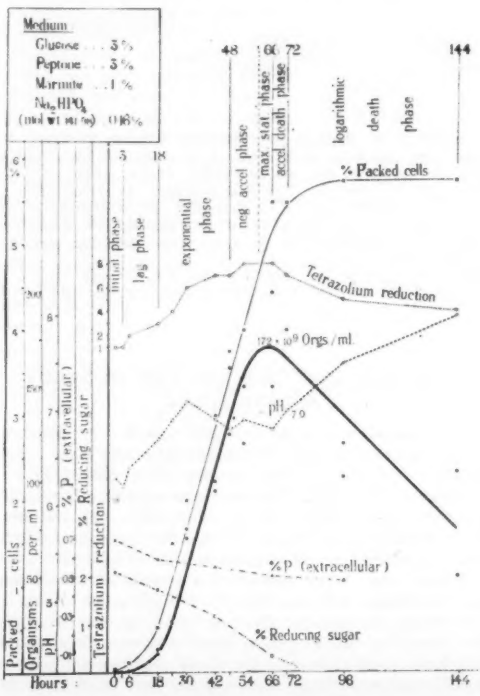

Fig. 1. Growth curve of *Brucella abortus S.*19 in shake-flask culture

The exponential phase of growth in this culture occurred between the twentieth and sixtieth hour of incubation (Fig. 1). *S*- to *R*-variation was not observed, and antigenicity tests consistently gave results identical with those of surface culture vaccine. Reactions produced in vaccinated animals were also identical. The output of the laboratory was increased tenfold by the adoption of this technique[3].

I am indebted to Dr. R. A. Alexander, director of Veterinary Services, for encouragement and help.

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Production of Plaques with Influenza Viruses

THE demonstration of the production of plaques, that is, necrotic foci, in tissue culture with the viruses of Eastern equine encephalomyelitis[2], Western equine encephalomyelitis[2], Newcastle disease[2], vaccinia[3], and poliomyelitis[4], offers additional quantitative applications to the study of these viruses. A necessary condition for the development of a plaque in tissue culture has been shown to be a destructive activity of the virus on the tissue employed. With the demonstration of a highly destructive effect of the *WSE* strain of influenza *A* virus on various chick embryonic tissues (9-day chorio-allantoic membrane, and 14-day lung and liver in roller tube cultures, unpublished results), experiments were undertaken to show production of plaques with this virus. Using the technique of Noyes[3], plaques averaging 0·5 mm. in diameter were obtained in five days on chick embryonic layer tissue cultures with a high dilution of the allantoic fluids used. Attention was then directed to a less heterogeneous source of tissue, chick embryo lung. Plaque formation was shown to occur readily with this tissue not only with the *WSE* strain of influenza *A* virus, but also with the other influenza virus strains tested.

Lungs from thirty-six 14-day chick embryos were removed, washed twice with Earle's salt solution (*BSS*) and pressed into approximately 30 ml. of *BSS* through a wire mesh strainer having 10 strands per cm. After standing for 10 min. at room temperature, the supernatant containing cell debris was discarded. The sediment was resuspended in 18 ml. *BSS* (0·5 ml. *BSS* per one set of lungs) and rapidly pipetted twenty times with a 10-ml. pipette. The suspension was allowed to stand for 10 min. at room temperature, during which time the large particles settled into the bottom 1–2 ml. This was discarded, and the procedure repeated twice. The resulting preparation consisted mostly of a single-cell suspension. The cell concentration was determined in a hæmocytometer and the suspension diluted with nutrient fluid (40 per cent horse serum heated to 60° C. for 30 min.; 20 per cent embryo extract (1 : 2 in *BSS*) made from 9-day

chick embryos; 40 per cent *BSS*; 50 units of penicillin and 50 μgm. of streptomycin added per ml.; *p*H approximately 7·6) to give a final cell concentration of approximately 4×10^6 cells per ml. Usually the cell suspension was diluted 1 : 2·5 with the nutrient fluid.

Aliquots of 2 ml. of the final cell suspension in nutrient medium were added to 40-mm. flat bottles and allowed to settle on a glass surface coated with a thin layer of chicken plasma clot. The cultures were incubated overnight at 35° C. The uniform cell layers were washed twice with 2 ml. of *BSS*, and a virus sample in 2 ml. *BSS* introduced into the bottle. After incubation for 1–2 hr. at 35° C., the fluid was removed and the cell layer was covered with a thin layer of plasma clot in order to produce more discrete lesions. 2 ml. of nutrient fluid consisting of 25 per cent chick embryo extract and 75 per cent *BSS* were added, and this was renewed at intervals of two or three days. After five days of incubation at 35° C., neutral red (chloride vital) in *BSS* was added to the nutrient fluid (at a *p*H of 6·8–7·0) to give a final concentration of 1 : 5,000, and incubation continued for two additional days.

At this time plaques could be seen as white, opaque foci averaging 0·5 mm. in diameter, with a range of approximately 0·3–1 mm., against the background of living cells stained with neutral red. (Because of the uneven thickness of the glass surface of the bottles used, satisfactory photographs could not be obtained. However, the photographs of Noyes, using vaccinia virus[3], show comparable effects of virus concentration on staining with neutral red. The plaques produced by influenza viruses, under the experimental conditions used, are smaller than those produced by vaccinia virus.) That plaque production was due to viral activity was supported by the following: (1) plaques were absent when virus was absent; (2) specific antiserum inhibited the production of plaques; and (3) the number of plaques increased with the concentration of virus. With the exception of *PR*-8 virus, an approximate linear relationship between plaque count and the concentration of virus was reproducibly found.

Table 1 gives representative results of the testing of various influenza strains for their ability to produce plaques. Serial ten-fold dilutions were made of allantoic fluid viruses harvested about 40 hr. after inoculation of 11-day chick embryos with a 10^{-6} dilution of the previous passage allantoic fluid. The tissue culture infectious units/ml. as explained below, the 50 per cent egg infectivity end-point[5], and the last dilution of fluid producing hæmorrhages in the chick embryo after chorio-allantoic membrane inoculation of 12-day chick embryos, expressed as the chorio-allantoic membrane inoculation titre[6], are given. The figures are expressed as the reciprocal of the negative logarithms.

Table 1. Comparison of Plaque Production and Egg Infectivity Titrations using Various Influenza Virus Strains

Virus tested	Titration method		
	Tissue culture infectious units/ml.*	50% egg infectivity end-point	Chorio-allantoic membrane inoculation titre
WSE (Type *A*)	6×10^7	7·6	8
Mel (Type *A*)	$2·5 \times 10^7$	7·6	<1
NWS (Type *A*)	4×10^7	7·1	<1
PR-8 (Type *A*)	†	7·2	<1
Cam (Type *A'*)	3×10^7	7·1	<1
Cam + (Type *A'*)‡	4×10^6	7·0	7
Lee (Type *B*)	$3·5 \times 10^7$	7·4	<1
Mil B (Type *B*)	5×10^7	7·3	<1

* The titre *n* of infectious units per ml. is $n = y/vx$, where *y* plaques are produced by a volume *v* (in ml.) of a dilution *x*. For example, in the case of *WSE*, an average of twelve plaques was observed in a 10^{-7} dilution of the virus. Since 2 ml. of virus was used as the inoculum, the titre will be $12/(2 \times 10^{-7}) = 6 \times 10^7$ units per ml. In lower dilutions practically all the cells were destroyed, with the release of neutral red into the solution.

† In two out of four experiments, one or two plaques only were observed, at each dilution throughout a dilution series ranging from 10^{-2} to 10^{-6}. In the other two experiments, the number of plaques produced by *PR*-8 virus increased with the concentration of virus.

‡ *Cam* + is the recombinant strain obtained from the interaction of *WSE* and *Cam* viruses (ref. 8).

As shown in Table 1, all the influenza strains tested could produce plaques. There was no correlation between plaque production and the ability to induce hæmorrhages in the chick embryo. Taking into consideration the forty-fold difference in volume of the virus inoculum used in the tissue culture procedure with that used in the egg infectivity titration (0·05 ml. of a virus inoculum used per egg), it would appear that the former technique was somewhat less sensitive than the egg procedure. However, the virus inoculum in the tissue culture system is removed 1–2 hr. after inoculation, at a time when possibly not all the infecting particles have become attached to susceptible cells.

Preliminary experiments of the comparative behaviour of *WSE*, *Lee* and *PR*-8 viruses in roller-tube cultures of 14-day chick embryo lung revealed that *WSE* and *Lee* viruses produced almost complete degeneration of the cellular outgrowth, while *PR*-8 virus caused only a partial destruction. This potential difference between the viruses used in their ability to cause destruction of the outgrowing cells from the heterogeneous population of lung tissue, as well as the finding that the number of plaques produced by *PR*-8 virus did not increase with virus concentration reproducibly, is under further investigation.

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Elephant Seal Cow and Pup on South African Coast

An elephant seal cow with new-born pup was found on the remote Bredasdorp coast near Cape Agulhas (Cape Province) by one of us (H. B. D. K.) on October 6, 1953. The cow was suckling her black pup, estimated at three or four days old. Colour photographs were taken of the two animals, which were identified as *Mirounga leonina* Linneus.

There is no other record of a female elephant seal on the South African coast. The present one is of additional interest in also reporting the first successful birth of an elephant seal pup on this coast. Elephant seals occasionally come ashore on the Cape coast, and have been seen on fur seal islands as far north as Luderitz Bay, South-West Africa. Recent reports are: Cape Peninsula, March, May 1949,

February 1950; Knysna, January 1953. The animals were all males.

After the breeding season, male elephant seals leave the rookeries for about two months, before returning again for their annual post-nuptial moult. The whole herd disappears for the winter to lead a pelagic life, presumably near the pack ice of the Antarctic[1]. Solitary individuals (stragglers) dispersing to warmer waters in the north pose a peculiar problem of distribution. No elephant seals have resorted in numbers to the South African coast within historical times. The nearest rookeries are Prince Edward Islands (900 miles south-south-east) and the Tristan da Cunha group (1,500 miles west). It would appear that the elephant seals are capable of ranging considerable distances. The present record of a cow successfully giving birth nearly a thousand miles from extant herds is perhaps some evidence of the mechanism of dispersal of breeding populations, at present little understood among the pinnipedes.

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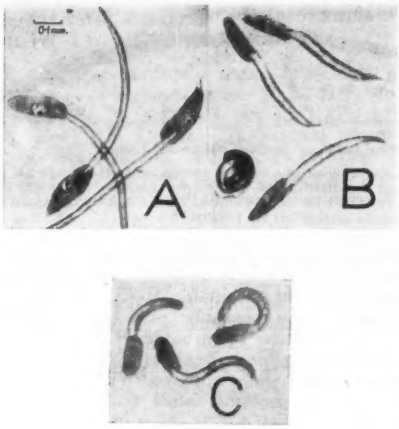
Production of Abnormal Metamorphosis in a Tunicate

In this laboratory control hatchings of 95 per cent normal control tadpoles are regularly obtained from cross-fertilized eggs of *Ciona intestinalis*. The addition of phenylthiourea to the sea water in which they are developing produces a characteristic abnormality, which has been obtained regularly. A concentration of 0·001 per cent is effective, but not 0·0001 per cent. Apart from the interference with melanization of sensory vesicle structures, which is known in vertebrates[1], this drug prevents the normal elongation of the notochord. Such tadpoles have short curved tails and do not swim. They remain unchanged after hatching for up to five days, when some attempt metamorphosis, which may be successful in the lower concentrations. Control tadpoles are usually 100 per cent attached and metamorphosing 24 hr. after hatching. When the monsters are placed in normal sea water on hatching, they remain unchanged except for melanization of the sensory vesicle. If, however, they are placed in 0·2 per cent phenylalanine in sea water, the tails are absorbed in 24 hr.; dihydroxyphenylalanine, thyroxine and tyrosine are less effective, approximately in that order. Glycine and alanine do not have this action.

The partial overcoming of the block in metamorphosis by phenylalanine suggested using it together with phenylthiourea. Eggs developing in solutions of 0·05–0·1 per cent phenylthiourea with 0·05–0·2 per cent phenylalanine produced a new monster with greatly retarded head development. In some cases the sensory vesicle is suppressed. As phenylthiourea is an antithyroid drug, another—2-thiouracil—was investigated. Animals developing in from saturated to one-tenth saturated solutions hatched to normal tadpoles, though metamorphosis was retarded up to twelve days and was irregular. The chief effect was a retardation of tail absorption.



A, Normal control tadpoles of *Ciona intestinalis*. *B*, Tadpoles which have developed in 0·01 per cent phenylthiourea. *C*, Tadpoles which have developed in phenylalanine and phenylthiourea

It seems that the phenylthiourea monster is not primarily due to antithyroid effects.

This work is being continued. Possible antagonists to phenylalanine are being investigated, as is also the influence of the composition of the sea water on the response to the drugs. The *p*H of the solutions used has varied from 7·6 to 8·2, and normal development occurs in this range in the absence of drugs.

It is easy to obtain many abnormal forms by overcrowding and using dirty glassware, but the phenylthiourea tadpoles are obtained under conditions which give perfect control tadpoles in the absence of the drug.

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Chromaffin Tissue in the Lizard Adrenal Gland

Both adrenaline and its possible precursor noradrenaline can be obtained from the adrenals of many animals in the different classes of vertebrates[1]. In the dogfish, where adrenocortical and chromaffin tissue are entirely separate, the latter contains wholly noradrenaline[2]. In the Amphibia, where the two tissues are intermingled, noradrenaline forms 50–69 per cent of the total catechol content in the frog[2] and 35–58 per cent in the toad[3]. In the eutherian mammal, chromaffin tissue, formed as a medulla surrounded by cortical tissue, produces mostly adrenaline[1,2,4].

In this laboratory, where the comparative anatomy and physiology of the vertebrate adrenal is being investigated, it has been found that the chromaffin tissue of the lizard adrenal gland (*Lacerta viridis* Laur.) is distributed in a particularly interesting way. The chromaffin cells form two groups of tissue, one embracing the cortex and thickened considerably in the dorsal region of the gland—the peripheral layer—and the other forming 'tongues' and islets intermingling with the cortical cells themselves (Fig. 1).

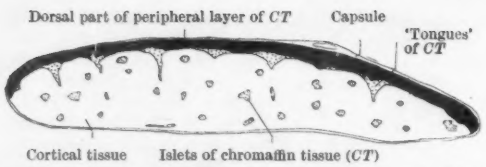

Fig. 1. A diagram of a sagittal section of the lizard adrenal gland showing the distribution of the two types of chromaffin tissue: *CT*, chromaffin tissue—peripheral layer black tongues and islets stippled

The two groups can be differentiated: (i) by using Hillarp and Hökfelt's iodination method[1], when the peripheral layer of chromaffin tissue acquires a deep brown granular appearance and the tongues and islets a non-granular fawn colour; deep brown pigment formation after iodination is indicative of noradrenaline, adrenaline not reacting in this way[1]; (ii) by staining sections, after fixation in Zenker-formol, with Ehrlich's hæmatoxylin and eosin, when the peripheral layer has a clear yellow colour and the islets and tongues become brownish-purple. Zenker-formol or 2·5 per cent potassium dichromate with adrenaline *in vitro* produces a deep brown colour and ultimately a precipitate, but with noradrenaline a light brown colour and no precipitate results. This may be due to the fact that adrenaline in solution is oxidized more rapidly than noradrenaline[5].

It is probable, then, that the peripheral layer of the chromaffin tissue in the lizard adrenal secretes noradrenaline, whereas the tongues and islets secrete adrenaline. It seems that the cytoplasm of adrenaline-producing cells has a basophilic property brought out by treatment with Ehrlich's hæmatoxylin, and that this is not the case with the noradrenaline-producing cell, the cytoplasm of which is unaffected by hæmatoxylin.

The distribution of chromaffin tissue in the adrenal of the lizard supports the view that adrenocortical cells must be contiguous to influence the formation of adrenaline, perhaps by methylation of noradrenaline[3]. Presumably this transformation demands adrenocortical steroids in high local concentrations which can only be obtained by the close juxtaposition of chromaffin and cortical tissue. The fowl adrenal is exceptional in that, despite the close intermingling of cortical and chromaffin tissue, it contains 70–80 per cent noradrenaline[6], and we have found, using histological methods, a similar predominance of noradrenaline in the pigeon adrenal. This is difficult to explain, though it may be possible that variations in the availability of ascorbic acid is one of the essential factors involved.

Certainly the general pattern of change of adrenal form throughout the vertebrates is one of increasing association of cortical and chromaffin tissue, coupled with a changing proportion of noradrenaline to adrenaline. It will be interesting to discover if this variation in proportion is of physiological significance in the different classes of vertebrates.

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Emergence of the Sporoplasm in *Nosema helminthorum*

The mode of emergence of the infective sporoplasm from Microsporidian spores has baffled protozoologists for many years. According to earlier workers, the sporoplasm creeps out through the aperture from which the filament is extruded. Korke[1], Ohshima[2], Trager[3] and Gibbs[4] have described a protoplasmic globule at the tip of the extruded filament of the species studied by them. Ohshima and Gibbs thought that the filament pierces through the tissues, 'injecting' the sporoplasm into the host cell; filament extrusion, according to them, being either in a jack-in-the-box manner[2] or by eversion like the nematocyst of a cœlenterate[4]. As Kudo[5] has remarked, these views ignore the delicate nature of the filament and the fact that the force required to inject the sporoplasm through a long tubular filament would injure it.

I have made some observations on *Nosema helminthorum* Moniez, 1887, which shed light on this problem and indicate the likely arrangement of structures within the mature spore. Spores from infected segments of *Moniezia expansa* left overnight in the refrigerator were examined in a drop of water covered with a cover-slip and lightly pressed. Several spores showed extruded filaments with globular masses attached to their tips; the corresponding spores were completely empty. This preparation was soon dry-fixed after gently removing the cover-slip, and stained in Giemsa stain. The resulting preparation showed more than twenty spores with extruded filaments having an irregular flattened mass at their tips (Fig. 1). These masses of protoplasm, which undoubtedly were the sporoplasms, were seen to be continuations of the filaments and each had a single nucleus also of irregular outline.

From these observations I conclude that the sporoplasm is normally attached to, and is probably a continuation of, the polar filament, which is not hollow. It would seem that inside the spore the coiled filament is surrounded by the sporoplasm in a girdle-like fashion. When the filament is extruded, it is 'whipped out' through a weak place in the anterior end of the spore in a 'jack-in-the-box' manner. The sporoplasm, being a continuation of the filament, is dragged out with it. In some sporas, extrusion is so rapid that the sporoplasm is left behind at the aperture of the spore; in other instances the sporoplasm breaks away from the tip of the filament after complete extrusion. This would explain the observations of earlier workers, who appear to have seen the sporoplasm at the aperture, and also the fact that in most instances the extruded filament

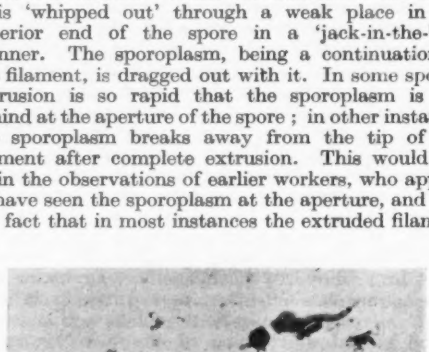

Fig. 1. Photomicrograph of a spore of *Nosema helminthorum*, showing sporoplasm at the tip of extruded filament. (× 700)

does not show any structure at its tip although the spore is completely empty. Finally, I do not think that a polar capsule exists in the spores, nor do I believe that such a delicate structure as the polar filament can penetrate the thick cuticle of *Moniezia*. I suggest that all it does is to help apply the very fluid sporoplasm to the host tissue, and that thereafter the sporoplasm works its way in by secreting a histolytic substance.

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Uses of the Globe Photometer

ONE may measure the vertical component of daylight in any site by exposing a photometer with a plane perfectly diffusing surface set horizontally. For certain purposes one may set the photometer so as to receive the maximum illumination possible. These illuminations may be expressed as percentages of the diffuse light of the whole sky. Much attention has been given to such determinations in the design of modern buildings.

We measured these daylight factors about twenty-five years ago when studying plant growth in woodlands, illumination in houses and in the sea. For this work vacuum photo-cells were used, also solutions of uranium oxalate in tubes or flasks. The flask[1] gives a better measure of the illumination as it affects plant growth, since it receives light from all angles as a bush does, and it is equally sensitive to sunlight at any angle.

Later[2] we described a globe photometer in which a selenium rectifier cell—a disk—was mounted horizontally under the usual opal-flashed glass plate but covered with both an opal hemisphere and an opal globe, so as to render the disk equally sensitive to sunlight at any angle.

Using two such globes, one can determine the illumination at a shaded point expressed as a percentage of the total diffuse light in the open, namely, I/I_{sky}, as against V/V_{sky}. The former gives a more satisfactory expression for the general lighting of a room, direct and indirect, especially as to plant growth. With the selenium cells low-resistance galvanometers must be used and the form of the current/illumination curve must be determined.

More recently, we have assembled a globe photometer with a thin-film cæsium-on-silver-oxide vacuum photo cell, a type which had proved constant in sensitivity when exposed for more than three years on a roof. This is free from temperature error and always gives a rectilinear relation between current and illumination. It is thus suitable for use in recording daylight over a long period.

W. R. G. ATKINS
H. H. POOLE

Royal Dublin Society.
Jan. 20.

[1] Atkins, W. R. G., and Poole, H. H., *Sci. Proc. Roy. Dublin Soc.*, **19** (18), 173 (1929).
[2] Atkins, W. R. G., and Poole, H. H., *Phil. Trans. Roy. Soc.*, A, 235 (752), 245 (1936).

Rotational Analysis of the Tantalum Oxide Bands

THE bands of tantalum oxide have been photographed in the second order of a 21-ft. concave grating having 30,000 lines per inch and giving a dispersion of 0·6 A./mm. Rotational structure of three of these bands, λ 3,747 (ν 26,679), λ 4,155 (ν 24,063) and λ 4,282 (ν 23,348), has been analysed; the first of these is the (0,0) head of one system and the other two are the (1,0) and (0,0) heads of another system of TaO[1]. The analysis indicates that (1) the three bands have a common Σ ground-state which is probably a doublet, (2) ν 26,679 results from a transition between two doublet Σ states, and (3) ν 23,348 and ν 24,063 are attributed to the transition $^2\Pi - {}^2\Sigma$.

The following constants have been determined for the different states involved in the emission of these bands:

Ground state Σ	Excited state Σ	Excited state $^2\Pi_{3/2}$
$B_0 = 0{\cdot}3434$ cm.$^{-1}$	$B_0 = 0{\cdot}3205$ cm.$^{-1}$	$B_e = 0{\cdot}3178$ cm.$^{-1}$
$I_e = 81{\cdot}51 \times 10^{-40}$ gm. cm.^{2}	$I_e = 87{\cdot}34 \times 10^{-40}$ gm. cm.^{2}	$B_0 = 0{\cdot}3156$ cm.$^{-1}$
$r_e = 1{\cdot}827 \times 10^{-8}$ cm.	$r_e = 1{\cdot}891 \times 10^{-8}$ cm.	$B_1 = 0{\cdot}3112$ cm.$^{-1}$
		$a = 0{\cdot}0044$ cm.$^{-1}$
		$I_e = 88{\cdot}06 \times 10^{-40}$ gm. cm.^{2}
		$r_e = 1{\cdot}900 \times 10^{-8}$ cm.

The D values in all cases are of the order of 10^{-6} cm. A study of the Λ type doubling in the two bands ν 23,348 and ν 24,063 indicates that the $^2\Pi$-state belongs to a near case (a) of coupling and is probably inverted. Details of this work will be published elsewhere.

D. PREMASWARUP

Physics Department,
Andhra University,
Waltair.
Jan. 8.

[1] Premaswarup, D., *Ind. J. Phys.* (in the press).

Origin and Age of Meteorites

IN his recent article under this title[1], Prof. H. C. Urey says: "While the excellent studies of Paneth and his co-workers are most interesting because of the facts which they present about the formation of meteorites and the effects of cosmic rays, I believe that it is very difficult to decide what event or events were recorded by the helium, uranium and thorium abundances".

We should like to put on record that we agree with Prof. Urey that there are difficulties in the interpretation of our results; but that we do not think that his statements prove that our arguments, leading to an age of no more than a few hundred million years, are incorrect. We are not convinced that his interesting thermodynamic reasoning can be applied to the calculation of the maximum quantities of uranium and thorium in iron meteorites, since it is by no means certain that their distribution was achieved under equilibrium conditions.

Prof. Urey conjectures that the uranium and thorium are present only in silicate and sulphide inclusions, and that the helium has leaked from these inclusions along fissures. While it is true that some meteoritic irons do contain substantial inclusions and fissures, we should like to direct attention to the fact that the beautifully homogeneous Savik iron (in which

the uranium was determined, with concordant results, by four different methods) has no visible inclusions. The total volume provided by fissures would be so small that it would be necessary to assume in them a concentration of uranium far greater than is, in fact, found in silicates or sulphides of meteoritic origin.

A definite test whether or not the radioactive material is concentrated along fissures could be obtained by photographic methods which, however, are difficult in this case owing to the very low activities. We are much indebted to Dr. E. Picciotto, of the Laboratoire de Physique Nucléaire at Brussels, for privately showing us preliminary results obtained by him and Mrs. Deutsch with a slice of the Carbo meteorite; these do not seem to us to lend any support to Prof. Urey's hypothesis; but Dr. Picciotto hopes to increase the accuracy, and his final results will be awaited with great interest.

In the last paragraph but one of his article, Prof. Urey refers in four or five consecutive sentences to as many possibilities for the origin and age of meteorites. We would like to suggest that our views should be added as one more possibility.

F. A. Paneth
Max-Planck-Institut für Chemie,
Mainz.

G. R. Martin
S. J. Thomson
Londonderry Laboratory for Radiochemistry,
University of Durham.

[1] *Nature*, **175**, 321 (1955).

"Applied Statistics"

In his review of my book "Statistical Methods in Electrical Engineering" (*Nature*, March 19, p. 484), Mr. F. Downton criticizes my statement that Bayes' theorem is controversial. The heading of the paragraph in Sir Ronald Fisher's book which I cited is "The Rejection of Inverse Probability". Coupled with the lack of mention of Bayes beyond the introductory chapter, I can only take this to mean that the author did not accept the rigorous validity of anything which Bayes formulated. To me, therefore, it appears that Mr. Downton's statement is demonstrably untrue. Faced with this controversial issue when writing a practical book, I decided to mention the existence of the controversy and then take a firm decision (the opposite of Fisher's) which was justified primarily on empirical grounds.

The question of $\sqrt{(N-1)}$ depends on a distinction between (*a*) the dispersion of a group of observations and (*b*) the probable difference between the mean of the group and a determinate true value.

If my book should survive the disfavour of statisticians and reach a second edition, I will bear in mind Mr. Downton's suggestion that congestion theory should be mentioned, though I should not attempt to satisfy his desire for a "definitive" treatment of this subject.

D. A. Bell
Electrical Engineering Department,
University of Birmingham.

The position with regard to Bayes' theorem is admirably set out in M. G. Kendall's "The Advanced Theory of Statistics", Vol. 1, pp. 175–176 (3rd edit., 1947), where my statement that it is the assumptions and not the theorem which are controversial is supported. Reconciliation of the quotations from Fisher, Jeffreys and my review, which Dr. Bell finds contradictory, depends on the recognition that the terms 'postulate', 'axiom' and 'theorem' are not synonymous.

The extract from Dr. Bell's book, which I quoted in my review, makes it quite clear that he stated, erroneously, that the standard deviation of the mean of N observations varies inversely as $\sqrt{N-1}$ (that is, presumably, case (*b*) above); for the correct expression see any elementary text-book; for example, C. E. Weatherburn, "A First Course in Mathematical Statistics", p. 185 (1946). It is to be hoped that this correspondence will not give readers the impression that these are matters which are likely to cause disagreement among statisticians.

F. Downton
Department of Applied Mathematics,
University of Liverpool.

An Amplifier based on the Hall Effect

The achievement of a Hall effect amplifier by Ross and Thompson, as recorded in *Nature* of March 19, p. 518, is quite remarkable, even taking into consideration the very high carrier mobility obtainable with indium antimonide. Calculation shows that a power gain is only possible if every effort is made to get the required magnetic field with the minimum power input, and this clearly entails the use of a high permeability core with a very thin crystal in a correspondingly small air-gap. The power gain is derived from the input of current to the crystal, and theoretically there appears to be no limit to the amplification obtainable if it were possible to raise the strength of the magnetic field indefinitely. In practice, saturation must occur. By the same argument an input signal applied to the current terminals of the crystal when immersed in a steady magnetic field could not lead to amplification. There is then no independent source of power input, and in this case the usual expression for the Hall output cannot therefore remain valid with large signals. The amplifier of Ross and Thompson seems to be limited to low-frequency applications unless a semi-conductor of still higher carrier mobility becomes available.

It should be possible to make the amplifier into an oscillator by feeding back the output from the Hall terminals to the magnetizing coil.

H. M. Barlow
University College,
London, W.C.1.

We agree with Prof. Barlow that considerable refinement in technique is required to achieve gain. In addition to those points which he mentions as essential, it is necessary also to have very good thermal contact between the crystal and the magnetic core, in order that a high input current density may be used without appreciable heating of the crystal. Although only small power gains have so far been achieved, we think that the device is capable of considerable development.

I. M. Ross
N. A. C. Thompson
Services Electronics Research Laboratory,
Baldock, Herts.

FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

Monday, June 6

ROYAL GEOGRAPHICAL SOCIETY (at 1 Kensington Gore, London, S.W.7), at 8.30 p.m.—Mr. G. Hattersley-Smith: "Ellesmere Land".

Tuesday, June 7

WRIGHT-FLEMING INSTITUTE OF MICROBIOLOGY (at St. Mary's Hospital Medical School, London, W.2), at 5 p.m.—Prof. B. Ephrussi: "Intrinsic Factors Controlling the Synthesis of Cytochromes in Yeast" (Almroth Wright Lecture).

INSTITUTION OF CIVIL ENGINEERS (at Great George Street, Westminster, London, S.W.1), at 5.30 p.m.—Annual General Meeting.

UNIVERSITY OF LONDON (at the Imperial College of Science and Technology, Imperial Institute Road, London, S.W.7), at 5.30 p.m.—Prof. G. A. Barnard: "Technometrics and the Mathematical Needs of Modern Technology"* (Inaugural Lecture).

Tuesday, June 7—Saturday, June 11

OIL AND COLOUR CHEMISTS' ASSOCIATION (at the Grand Hotel, Llandudno)—Conference on "Film Structure and Adhesion".

Wednesday, June 8

GEOLOGICAL SOCIETY OF LONDON (at Burlington House Piccadilly, London, W.1), at 5 p.m.—Scientific Papers.

Thursday, June 9

ROYAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 11 a.m.—Discussion on "Radiative Balance in the Atmosphere", opened by Prof. H. S. W. Massey, F.R.S.

BRITISH SOCIETY FOR RESEARCH IN AGEING (at the Ciba Foundation, 41 Portland Place, London, W.1), at 2 p.m.—Symposium on "Endocrinology and Ageing".

INSTITUTION OF NAVAL ARCHITECTS (in the Weir Lecture Hall, 10 Upper Belgrave Street, London, S.W.1), at 4.45 p.m.—Mr. W. Muckle: "The Influence of Dimensions on the Behaviour of Partial Superstructure"; Mr. J. B. Caldwell: "The Strength of Corrugated Plating for Ships' Bulkheads".

BONE AND TOOTH SOCIETY (at the Institute of Orthopædics, 234 Great Portland Street, London, W.1), at 5 p.m.—Annual General Meeting, followed by "Casual Communications".

MEN OF THE TREES (at Chelsea Physic Garden, Swan Walk, London, S.W.3), at 5 p.m.—Annual General Meeting. Mr. N. W. Pirie, F.R.S.: "New Ways with Trees".

MINERALOGICAL SOCIETY (in the Apartments of the Geological Society of London, Burlington House, Piccadilly, London, W.1), at 5 p.m.—Scientific Papers.

Friday, June 10

UNIVERSITY OF LONDON (in the Physiology Theatre, University College, Gower Street, London, W.C.1), at 5.30 p.m.—Prof. O. Krayer (Harvard Medical School): "New Aspects of the Pharmacology of Veratrum Alkaloids—The Anti-accelerator Cardiac Action of the Secondary Amines".*

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 9 p.m.—Sir Graham Sutton, F.R.S.: "Weather Forecasting—the Future Outlook".

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

PHYSICIST (honours graduate) in the Physics Department, mainly for work connected with radiotherapy by X-ray and gamma-rays (including a 1,000-curie radiocobalt and a 4 million volt linear accelerator)—The Secretary and House Governor, Mount Vernon Hospital, Northwood, Middlesex (June 10).

ASSISTANT, Grade B (with graduate or equivalent qualifications, and preferably with teaching, industrial or research experience) IN CHEMISTRY—The Registrar, The Technical College, Sunderland (June 11).

ASSISTANT LECTURER IN PHYSICS—The Registrar, Queen Mary College, Mile End Road, London, E.1 (June 11).

DEMONSTRATORS IN THE SCHOOL OF CHEMISTRY—The Registrar, The University, Leeds 2 (June 11).

LECTURER IN GREEK ARCHÆOLOGY AND ANCIENT HISTORY—The Registrar, King's College, Newcastle-upon-Tyne (June 11).

RESEARCH ASSISTANTS (preferably graduates with some experience of single-crystal X-ray diffraction methods) IN THE CRYSTALLOGRAPHIC SECTION of the Cavendish Laboratory for the structure analysis of organic crystals, minerals and alloys—The Secretary of the Department of Physics, Cavendish Laboratory, Free School Lane, Cambridge (June 11).

DEMONSTRATOR (with a good honours degree in physiology, biochemistry, or chemistry, with subsidiary physiology, or medically qualified) IN CHEMICAL PHYSIOLOGY—The Registrar, The University, Manchester 13 (June 13).

LECTURER, Grade II, and an ASSISTANT LECTURER, Grade III, or a RESEARCH FELLOW, IN THE DEPARTMENT OF THEORETICAL MECHANICS, Faculty of Engineering—The Registrar, The University, Bristol (June 13).

JUNIOR LECTURER IN MATHEMATICS—J. S. de Wet, Balliol College, Oxford (June 17).

ASSISTANT LECTURER (preferably with a medical qualification) IN THE DEPARTMENT OF PHARMACOLOGY—The Welsh National School of Medicine (University of Wales), 34 Newport Road, Cardiff (June 18).

LECTURER IN METALLURGY—The Registrar, The University, Sheffield (June 18).

LECTURER or ASSISTANT LECTURER (with special interests in physico-organic chemistry) IN CHEMISTRY—The Secretary, University College, Exeter (June 18).

RESEARCH ASSISTANT (graduate, with previous experience in the field of natural product chemistry, preferably in isolation and degradative studies on alkaloids) IN THE DEPARTMENT OF CHEMISTRY, University College of the Gold Coast—The Secretary, Inter-University Council for Higher Education Overseas, 1 Gordon Square, London, W.C.1 (June 22).

RESEARCH OFFICER (with a university honours degree in science with organic chemistry as a major subject, and knowledge and experience in the use of modern techniques of isolation and separation) IN THE ORGANIC CHEMISTRY SECTION, Alkaloids Subsection, Commonwealth Scientific and Industrial Research Organization, Fishermen's Bend, Melbourne, Australia, to carry out investigations on the chemistry of substances given out by plant roots—Chief Scientific Liaison Officer, Australian Scientific Liaison Office, Africa House, Kingsway, London, W.C.2, quoting 590/551 (June 24).

SENIOR RESEARCH OFFICER or RESEARCH OFFICER (with broad scientific interests and a university honours degree or equivalent in science, and preferably with research experience) IN THE DIVISION OF BUILDING, Commonwealth Scientific and Industrial Research Organization, Highett (near Melbourne), to undertake research both basic and applied, on fibrous plaster—Chief Scientific Liaison Officer, Australian Scientific Liaison Office, Africa House, Kingsway, London, W.C.2, quoting 390/217 (June 24).

TECHNICAL SECRETARY (with a university honours degree in science, with chemistry or fuel technology as a major subject or equivalent qualifications, and with research and/or industrial experience in fuel technology) IN THE COAL RESEARCH SECTION, Commonwealth Scientific and Industrial Research Organization, North Ryde, N.S.W., Australia, to assist the Officer-in-Charge in the administration and initiation of research concerned with the properties and utilization of Australian coals—Chief Scientific Liaison Officer, Australian Scientific Liaison Office, Africa House, Kingsway, London, W.C.2, quoting 480/164 (June 24).

SENIOR LECTURER, a LECTURER, and an ASSISTANT LECTURER IN THE DEPARTMENT OF PHYSICS, to work or carry out research in one or more of the following fields: nuclear physics, theoretical physics and radio-astronomy—The Registrar, The University, Manchester 13 (June 25).

CHAIR OF AERONAUTICS—The Secretary, Queen's University, Belfast (June 29).

ASSISTANT LECTURER (with an honours degree in agriculture or agricultural economics, or equivalent qualifications) IN AGRICULTURE with special reference to Farm Management and Work Husbandry—The Registrar, The University, Reading (June 30).

CHAIR OF MATHEMATICS (Pure and Applied), and a SENIOR LECTURER IN PHILOSOPHY at the University of Natal, Durban, South Africa—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (South Africa, June 30).

SENIOR LECTURER IN PHYSICS at Rhodes University, Grahamstown, South Africa—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (South Africa, June 30).

LECTURER IN EXPERIMENTAL PHARMACOLOGY—The Secretary of University Court, The University, Glasgow (July 6).

ASSISTANT LECTURER IN PHILOSOPHY—The Registrar, University College of North Staffordshire, Keele, Staffs (July 7).

PHYSICIST (preferably well versed in radiological physics and some knowledge of isotope counting techniques) IN THE RADIOTHERAPY DEPARTMENT—Dr. C. M. Bethune, Superintendent, Victoria General Hospital, Halifax, Nova Scotia, Canada (July 15).

ASSISTANT LECTURER, Grade B, IN THE DEPARTMENT OF CHEMISTRY AND APPLIED CHEMISTRY—The Principal, Royal Technical College, Salford 5.

ASSISTANT LECTURER (graduate in chemistry or biochemistry, and preferably with experience in the food industry)—The Registrar, National College of Food Technology, Cranwood Street, City Road, London, E.C.1.

ASSISTANT LECTURER (with a good honours degree of a British university) to assist with teaching physics to the level of the B.Sc. special degree—The Registrar, Medway College of Technology, Maidstone Road, Chatham.

ASSISTANT STATISTICIAN, Assistant Experimental Officer or Experimental Officer grade (with a degree in mathematics, or economics with statistics, or equivalent qualifications) IN THE DEPARTMENT OF STATISTICS, Agricultural Research Statistical Service—The Secretary, Rothamsted Experimental Station, Harpenden, Herts.

EXPERIMENTAL OFFICER (graduate in agriculture or agricultural chemistry) IN THE CHEMISTRY DEPARTMENT, to assist with field experiments on fertilizers and on soil fertility problems—The Secretary, Rothamsted Experimental Station, Harpenden, Herts, quoting "160".

INDEPENDENT FORECASTER (with a university degree in physics or mathematics, and experience of independent forecasting and general work of a city meteorological office, forecasting for the general public and shipping, investigation of meteorological problems, routine climatological returns, and checking work of assistant staff) IN THE METEOROLOGICAL DEPARTMENT, Government of Bermuda, Bermuda—The Director of Recruitment, Colonial Office, Great Smith Street, London, S.W.1, quoting BCD.57/29/01.

LECTURER IN PHYSICAL METALLURGY—The Registrar, The University, Edgbaston, Birmingham 15.

LECTURER IN RUBBER TECHNOLOGY—National College of Rubber Technology, Northern Polytechnic, Holloway, London, N.7.

LECTURER or ASSISTANT LECTURER (with special qualifications in organic chemistry) IN PHARMACEUTICAL CHEMISTRY—The Registrar, The University, Nottingham.

LECTURER (with previous teaching experience and preferably industrial experience) IN PHYSICAL CHEMISTRY, to teach to special B.Sc. standard—The Principal, West Ham College of Technology, Romford Road, Stratford, London, E.15.

NUTRITIONAL CHEMIST (with an honours degree in chemistry or Associate of the Royal Institute of Chemistry) IN THE DEPARTMENT OF VETERINARY SERVICES AND ANIMAL HUSBANDRY, Uganda, to investigate the nutritional value of local foodstuffs and to undertake metabolism studies of indigenous farm livestock—The Director of Recruitment, Colonial Office, Great Smith Street, London, S.W.1, quoting BCD.67/9/09.

PHYSICIST, Senior Scientific Officer grade (with a first- or second-class honours degree or equivalent in physics, and at least three years postgraduate research experience of electronic measurement), at the Royal Aircraft Establishment, Farnborough, Hants, to undertake responsibility for instrumentation of supersonic wind tunnels, a hypersonic tunnel and a shock tube, and development of techniques for measurement and recording—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting A.169/5A.

PRINCIPAL SCIENTIFIC OFFICER or SENIOR SCIENTIFIC OFFICER (with a first- or second-class honours degree in chemistry or chemical engineering, and several years experience in chemical engineering practice as applied to research and development, and in pilot plant studies), to lead a team concerned with the development of a new chemical plant—The Senior Recruitment Officer, Atomic Weapons Research Establishment, Aldermaston, Berks, quoting 561/WGE/2.

READER or LECTURER IN CLASSICAL ARCHÆOLOGY—The Secretary of Faculties, University Registry, Oxford.

SCIENTIFIC OFFICERS (with a first- or second-class honours degree in chemistry or Associateship of the Royal Institute of Chemistry, or equivalent qualifications), for research and development work in analytical chemistry with particular reference to the provision of analytical methods for the control of processes in the manufacture of some less common elements—The Works Secretary, United Kingdom Atomic Energy Authority, Springfields Works, Salwick, Preston, quoting Ref. 947.

SENIOR LECTURER, LECTURER or ASSISTANT LECTURER IN PHYSICS, at the University College of Khartoum—The Secretary, Inter-University Council, 1 Gordon Square, London, W.C.1.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

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Imperial Forestry Institute, University of Oxford. Thirtieth Annual Report, 1953–54. Pp. 29. (Oxford: Imperial Forestry Institute, University of Oxford, 1955.) [313

The Manchester Museum, The University, Manchester. Report of the Committee for the year ending July 31st, 1954. Pp. 24. (Manchester: The University, 1955.) [313

Industrial Diamond Information Bureau. The Diamond Tool Industry in 1954. Pp. 12. (London: Industrial Diamond Information Bureau, 1955.) [313

Library Association. Year Book, 1955. Pp. lxviii+126+List of Members and Professional Register. 21*s*. (15*s*. to L.A. members). Library Association Pamphlet No. 12: Subject Specialisation and Co-operative Book Purchase in the Libraries of Great Britain. By K. G. Hunt. Pp. 32. (London: Library Association, 1955.) [54

Sir John Cass College. Report—Session 1953–54. Pp. 21. (London: Sir John Cass College, 1955.) [54

Forestry Commission. Bulletin No. 24: The Volume-Basal Area Line: a Study in Forest Mensuration. By Dr. F. C. Hummel. Pp. iv+84. 9*s*. net. Leaflet No. 8: Megastigmus Flies Attacking Conifer Seed. Pp. 10. 6*d*. net. (London: H.M. Stationery Office, 1955.) [54

Geography as a Humane Study. By Prof. E. W. Gilbert. (An Inaugural Lecture delivered before the University of Oxford on 12 November 1954.) Pp. 23. (Oxford: Clarendon Press; London: Oxford University Press, 1955.) 2*s*. 6*d*. net. [54

Carnegie United Kingdom Trust. Family Diet and Health in Pre-War Britain: a Dietary and Clinical Survey. (Report to the Carnegie United Kingdom Trust from the Rowett Research Institute.) Pp. 164. (Dunfermline: Carnegie United Kingdom Trust, 1955.) [54

University of Leeds. Annual Report of the Librarian, Session 1953–54. Pp. 11. (Leeds: The University, 1954.) [54

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Electrical Research Association. Technical Report Z/T84: The Pre-Nova Stage of a Star. By C. E. R. Bruce. Pp. 9. 6*s*. Technical Report L/T303: Growing of Perovskite-Type Crystals. By H. F. Kay and J. L. Miles. Pp. 11+1 figure. 7*s*. 6*d*. Technical Report L/T310: Breakdown of Solid Dielectrics in Divergent Fields. By J. H. Mason. Pp. 24+figures 1–16. 21*s*. (Leatherhead: British Electrical and Allied Industries Research Association, 1952 and 1954.) [54

Observations made at the Royal Observatory, Greenwich, in the year 1940 in Astronomy, Magnetism and Meteorology, under the direction of Sir H. Spencer Jones. Pp. viii+342. (London: H.M. Stationery Office, 1953.) 30*s*. net. [54

1955 Farm Holiday Guide. Edited by D. Murdoch. Pp. iii+112+24 plates. (Paisley: Farm Holiday Guides, 18 High Street, 1955.) [124

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United States Department of Agriculture. Technical Bulletin No. 1107: Ecological Studies on the Potato Psyllid as a Pest of Potatoes. By R. L. Wallis. Pp. 24. (Washington, D.C.: Government Printing Office, 1955.) 15 cents. [313

Metropolitan Life Insurance Company. Statistical Bulletin, Vol. 36, No. 2: Most Accidents Occur Off the Job. Pp. 12. (New York: Metropolitan Life Insurance Company, 1955.) [313

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United States Department of Agriculture. Circular No. 952 (December 1954): Flavor and Benzene Hexachloride Content of Peanuts Grown in Rotation with Cotton Dusted with Insecticides Containing Benzene Hexachloride. By Howard Reynolds and Gladys L. Gilpin. Pp. 26. (Washington, D.C.: Government Printing Office, 1954.) 15 cents. [54

Annales de l'Institut Phytopathologique Benaki. Année 8, Fascicule 1: Rapport sur les Travaux Expérimentaux de Lutte Contre le Dacus a Roviès (Eubée) pendant l'Année 1953. Par A. J. Ayoutantis, E. D. Pélécassis, Mlle. L. Ch. Argyriou, P. A. Mourikis et L. E. Tsacas. Pp. 75+1 plate. (Athènes: Institut Phytopathologique Benaki, 1954.) [54

Academia Brasileira de Ciências. Principal Results about the Reactivity of Solids. By J. A. Hedvall. (Lecture at the meeting of the Academia Brasileira de Ciências, September 22, 1953.) Pp. i+11. (Rio de Janeiro: Academia Brasileira de Ciências, 1954.) [54

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United States Department of Agriculture. Leaflet No. 382: The Fowl Tick: How to Control It. (Washington, D.C.: Government Printing Office, 1955.) 5 cents. [124

Union of South Africa: Department of Mines. Bulletin 22: Bore-Hole Temperature in the Klerksdorp and Orange Free State Areas. By R. F. Bouwer. Pp. ii+35. (Pretoria: Government Printer, 1954.) 3*s*. [124

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